THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

VOL. IX. No. 207—12th YEAR.] LONDON, SEPTEMBER 25, 1860. [Subscription per Ann. 15s. in Advance 18s Credit. Price 8d. Unstamped.

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Applications to be forwarded to the MANAGER, Gas and Coke Company's Office, LOUGHBOROUGH, who will give further particulars, if required,

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Dorrington, Sept. 22, 1860.

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Further particulars may be ascertained and all necessary information obtained, upon application to me at my Office.

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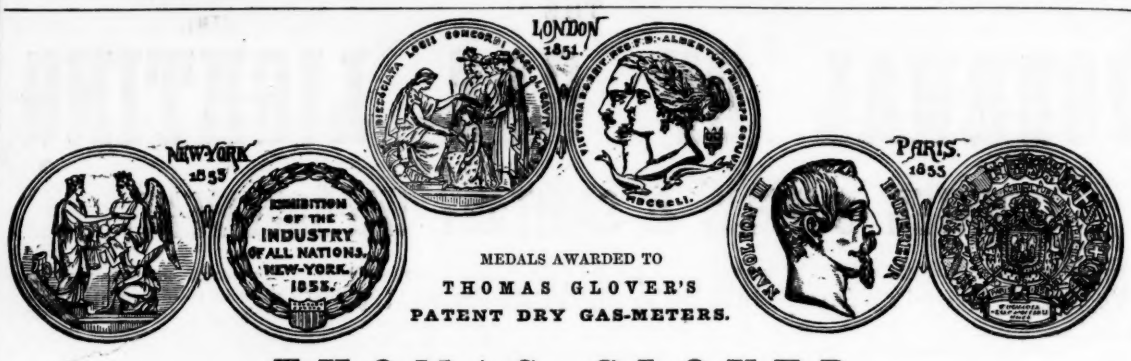
No pledge is given to accept the lowest or any other Tender.

By Order,
CHARLES E. DEACON,
Clerk to the Local Board of Health.
Southampton, Sept. 12, 1860.



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Graduated by the Standard Cubic Foot.

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NOTICES.

The subscription is 15s. per annum, if paid in advance during the month of January, or 18s. credit, in two sums of 9s. each, in July and January of each year. Post-Office orders must be made payable at the Charing-Cross Money-Order Office, to William H. Bennett, No. 42, Parliament Street, Westminster.

The next number will be published on Tuesday, Oct. 9, and the subsequent numbers on each successive alternate Tuesday.

Stamped copies, when forwarded by post, must be folded so as to expose the stamp; they are otherwise liable to the full postage charge for letters.

This JOURNAL has been duly registered at the General Post Office for transmission abroad.

All Communications to be addressed to the Editor, No. 42, Parliament Street, Westminster; and orders for Advertisements to the Publisher, Mr. W. B. King, No. 11, Bolt Court, Fleet Street.

THE JOURNAL OF GAS LIGHTING,
WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, SEPTEMBER 25, 1860.

NOTES UPON PASSING EVENTS.

THIS year of tremendous rain, during which nature has been repaying a debt accumulated in two dry seasons, must recal public attention to the unsatisfactory condition of Arterial Drainage in England. It is now upwards of fifteen years since the system of deep-till drainage was accepted by our leading agriculturists, and every year since an increasing number of acres has been brought under the operation of a system which relieves the soil of rain, by percolation, in the shortest possible time. We may fairly expect that an additional impulse will be given to this invaluable agricultural improvement by our long wet season. Many converts will be made to the advantage of under-draining clay, by ocular proof of the difference between the crops on the undrained and thorough-drained soil after six months of unceasing rain; indeed, man is so forgetful an animal that, after two seasons of dry weather, there were many who began to talk as if we could never have our soil too wet. Now, the effect of thoroughly draining a farm, and still more a district, is to rapidly swell the adjacent brooks and rivers; the effect the first year, on stiff retentive soils, is comparatively trifling; but, after two or three years, when the tile drains get into full work, a sharp shower finds its way subterraneously to the next brook in an incredibly short space of time. In the old times, when the only mode of getting the water off the land was by open furrow or shallow bush-drains, the ground remained long saturated like a sponge, and returned a large share of the rain to the clouds by evaporation, which is now conveyed by the tile drains direct to the nearest water-course, within a few hours after each shower; and thus it is that every year floods in river valleys become more frequent and more formidable. We hear this season of tens of thousands of tons of hay so much damaged by mud and sand-drift, that the farmers are in doubt whether to make it into manure or beat it out for use in threshing machines.

But there is another cause, in addition to the effects of agricultural thorough drainage, that aggravates these floods—that is, the increasing obstructions, natural and artificial, of our streams. Before the time of canal navigation, and still more before the time when the railway network embraced every market, there was a numerous and powerful body interested in keeping every water-course that would float a boat clear of obstruction. But, at the present day, only main lines of navigation are cared for, and the many feeders of our principal rivers are wofully neglected. Small obstructions grow by degrees into serious barriers: banks fall in—rotten trees make dams—weeds accumulate. To these natural obstructions are added the encroachments of the millers. It is not unfrequent to find a mill worth a hundred a year at most, backing up water which, in time of flood, will half ruin the produce of a couple of thousand acres. Thus, for the last ten or fifteen years, our water valleys have had to endure the combined injury of an annually increasing quantity of water poured into streams which are annually more and more obstructed. It is true that many mills have been rendered less valuable by the competition of steam-power in districts where coal is cheap, and by the course of the flour-making trade gradually drawing towards towns and railways; but a water mill is seldom discontinued. Still the fact remains that, at a time when grass and hay, as well as corn, are urgently required, neglected streams destroy or injure a wide breadth of pastures, and even corn-fields. The amendment of this increasing evil is retarded by the difficulty of apportioning the advantage of river reforms among the river-side proprietors. No works can be executed without expense. The opposition of the vested interests of the millers is certain, and that of some of the people to be taxed for the improvement is equally certain. For these reasons, it is almost impossible to obtain an Act of Parliament for a River Improvement at a reasonable cost; yet there are many small brooks where all that is needed to benefit some hundred acres is power to expend a few pounds. The remedy would be most likely to be found in local investigations and local powers, acting under one general Act of Parliament. It has been proposed to establish County Boards, elected by the ratepayers for the transaction of the business at present managed by the magistrates alone. Such boards, if constituted so as to secure the due representation of property and the tax-paying community, might safely be intrusted with powers similar to those now enjoyed by municipal corporations. As to the execution of the amendment of Arterial Drainage, the cost ought to fall partly on local and partly on national funds. The collection of information as to the condition of our non-navigable streams in rural districts, would be a proper subject for the investigations of the Royal Agricultural Society, but the council of that eminently respectable body seem content to concentrate all their energies in producing animals which are generally too fat to breed, and always too fat to eat.

The question of the Embankment of the Thames appears to interest even our Transatlantic brethren, for our article of the 14th of August on the subject has been quoted in full by a Philadelphia paper, *The United States Railroad and Mining Register*. On Mr. Bidder's suggestion, "That tramways be laid down on the embankment, and let out for the exclusive use of parties engaging to run omnibuses of great size at short intervals and low fares," the editor remarks: "Think of tramways and omnibuses in these days of street railways and city passenger cars! Omnibuses of great size, or any size, running through dense thoroughfares in a great city, are a nuisance which no city population will tolerate after having tested the superiority of the American Street Rail Car." Very probably he is right.

The idea of Street Horse-worked Railways has recently made so much progress in metropolitan public opinion, not a little assisted by the unsatisfactory working of the General Omnibus Company, that we shall not be surprised to see a Street-Railway Bill, subject to the consent of the parishes traversed, passed next Session. The bill brought forward for this purpose in 1858 proposed "tramways from Bayswater to the Bank and Farringdon Street—the western branch to enter the City at Victoria Street, pass along Farringdon Street, and terminate at the foot of Ludgate Hill; and the other branch to enter at Finsbury, pass along the pavement, and stop at the southern end of Moorgate Street." The rail then proposed was a tramway, with a groove, which, according to the diagram in Mr. Train's pamphlet, has been altered into a slight convex projection, on which a flanged wheel will work. The Bill of 1858 proposed to take compulsory powers which it would be out of the question to grant to any private company in a town where constituted authorities exist. Any Street-Railway Company

must be content to work under the control of the boards which have the charge of the roads. It is not surprising that, claiming such powers, the bill of 1858 was reported against by the engineer and opposed by the Commissioners of Sewers of the City of London. Some idea of the enormous traffic of certain districts in the City of London may be gathered from a report of Mr. Haywood's, the City engineer, on the propriety of substituting iron for the tramways. In the Commercial Road there are two miles of tramway, principally of Aberdeen, Devon, and Guernsey granite. The annual traffic is estimated at 118,000 vehicles, travelling at a velocity of from 3½ to 7 miles an hour, without counting those vehicles which do not traverse the tramway for its whole length. In Fenchurch Street, where the traffic is enormous, the wheels have cut ruts in the edge of a single line of tram-stone next to the kerbs, *averaging* three-quarters of an inch in depth within a period of twelve months.

If we are to judge from a letter addressed by a Mr. Francine to the editor of the Philadelphia journal already quoted, the art of sewering towns is in a very elementary condition in the United States. Mr. Francine is evidently better acquainted with books than work, and with the books of mere theorists than with the reports of practical and scientific engineers like those who have the charge of our London sewers. There are some passages in this letter which sound very like the rhapsodies of our defunct Board of Health, where a lawyer and a doctor clubbed together to find the engineering science and the literature. For instance, our American friend starts with the poetical fallacy that "the drainage of a City is of more importance in a point of view of health than the introduction of water;" and that "the various important considerations to be attended to in the laying out of a town or city ought to be carefully revolved in the minds of a chemist and physician, as well as in that of the engineer, as the nuisance arising from the decomposition of refuse matter is deleterious to the health of the citizens, and, as in the case of the City of London, will create an after cost for reconstruction far exceeding the original cost." All this is rank nonsense, and just the sort of stuff we hear in our country towns when some pupil of Social Science volunteers a lecture on Sanitary Reform. Water to drink, water to cook, and water for washing, is the first necessity of a colonist or settler. Nature's own chemistry will dispose of sewerage where the population is thin, and a donkey cart will for a long time be as efficient for clearing the streets and emptying the cesspools. In the rare instance in which a town like Saltaire, in Yorkshire, or Belgravia, is completely planned before execution, and the projector is able to spare the capital needed for sinking the foundation of houses and the construction of streets several years in advance of the population, he need not consult a chemist to tell him that animal and vegetable matter will smell vilely when decaying, or a physician to learn the advantages of clean water and fresh air. His engineer will be glad of a good fall, and will tell him that, if there be no fall, then the sewerage, when it comes, must be pumped away, and that that is a frightfully expensive proceeding, which only a dense population can afford. A well-planned, well-executed set of sewers are no doubt a great blessing to a crowded city, although villages and small rural towns have existed and thriven for hundreds of years with cesspools only. A great city cannot, it is true enjoy the full benefit of water supply without sewers, because a cesspool would be filled too rapidly from the contents of water-closets. It is for this reason that it has been impossible to take water into the houses of any part of old and a large part of new Paris. There are no safe means of getting rid of the quantity which would have been consumed if water had been laid on as in England, where water-closets are found in every decent house. The cesspools would have overflowed, and the foundations of the houses would have been soaked with sewerage.

Planning beforehand all that a city will require is a Utopian theory. In the City of London some hundred miles of sewers out of a thousand have been reconstructed, and so have the streets and the houses over the sewers. Experience only can teach what will be required. We cannot order the boots and trousers for our lad to wear when he is twenty one! No where can the art of sewer-building be better studied by our American friends than in the City of London where, in one of the most ancient and most dense populations of Europe, all the resources of science and experience have been employed to execute a network of sewers, in which nothing has been done for effect and everything for permanence and utility. In one or two of the new streets of Paris, some very grand works are to be seen, but there money is no object: posterity is to pay! Mr. Francine quotes from often cited authorities the rate at which water must flow in an egg-shaped culvert to drive before it clay, sand, gravel, stones, &c. It may be more simply stated that sewerage will flow away and keep a culvert clear in a current of 2½ miles an hour; 3 miles better; beyond that speed, the sides of the sewer would be worn away by the increased friction. Mr. Francine's suggestion of boring a hole for the tubular house-drains communicating with the sewer or culvert, as you would for "an artesian well," is altogether impracticable. You cannot fit a tubular pipe into the earth as you would a cork into a bottle, and yet it ought to be packed in quite as tightly. An open cutting is the best plan; and, if not, a hole large enough for a man to work in, and fit and pack the tubes. "The self-acting valve between the end of the pipe drain and the brick sewer, suggested for keeping out stinks and rats, will be found like most self-acting contrivances a failure, always out of order. Drains should be trapped in the house, just as washing sinks are or ought to be. The plan suggested for covering the street side gutters with an overhanging slab is another theory that does not answer; being out of sight, gutters are out of mind, and get stopped up by accumulations of rubbish. Mr. Francine concludes his essay with one of those plausible fallacies which pass current, because they have been so often printed. He assumes with Mr. Chadwick and Mr. Mechi, the discovery of agricultural perpetual motion in the following repetition from the old Board of Health blue books—"It has been ascertained that the filth (sewerage) of a city may be carried 12 miles and raised 125 feet by a Cornish engine for 5 cents (2½d.) per ton profit. In this manner, 125,000 tons of manure might be obtained annually from this city, which quantity would highly fertilize 250,000 acres of land, and it is a question whether the produce of these acres would not feed all the inhabitants of the city?" In this paragraph there are as many mistakes as statements. It has been asserted certainly by Mr. Chadwick that because water can be pumped up and be delivered to a thousand customers next door to each other for 2½d. a ton, the liquid sewerage of a town could be delivered on the same terms; but no engineer has ever believed it, and no farmer in this country has ever offered to pay the price water consumers pay every day, and all the year round. Farmers only require rain for a few weeks in the year. Certainly one ton of liquid manure will not manure two acres of land—ten tons will not in our climate. But water alone may be more valuable near Philadelphia than any manure in England. The attempts made at great expense within the last ten years to make a profit of the liquid sewerage of towns have, it is well known, failed utterly; and near Paris a French engineer, who was inspired by Mr. Chadwick, has carried on the farm of Vanjours with the most unfortunate results for the shareholders. Liquid sewerage is not worth one-eighth of a penny a ton as manure; it may at times be invaluable as water.

The evidence given before the committee on the embankment of the Thames has recently been issued, and contains some interesting miscellaneous information on several subjects. For instance, we hear a great deal of the large sums expended on metropolitan improvements out of the general taxation of the country, but here we have the actual figures. The total voted by Parliament for thirty years, from 1830 to 1860, amounts to £515,394, but it is very unequally distributed. Battersea Park and Chelsea Bridge figure for upwards of £130,000; and the embankment between Vauxhall and Battersea Bridges, which is part of the same work, for as much more. The entrance to St. James's Park, and the bridge over the water there cost £8000. Westminster Bridge (unfinished), with approaches, has absorbed £214,000. Mr. Thwaites, the witness, quotes a sum of five and a half millions expended on other parts of the kingdom and colonies during the same period; but nearly the whole of this sum has been laid out on such works of utility as harbours of refuge, military and other canals in Canada—the Caledonian Canal figures for more than a quarter of a million—bridges, and roads. His argument founded on the proportion of taxation paid by London is much stronger. London pays 17½ per cent. under Schedule A, and 31 per cent. under Schedule D of the property and income-tax. In any case, an average contribution of £20,000 a year for thirty years is not much for the nation to pay towards the adornment of the metropolis, although some patriots may fairly complain that it has all been expended at one end of the town: the Pimlico Improvements have alone consumed

£170,000. Half a million would not be an unreasonable national contribution towards the embankment of the Thames. It seems that the widening of Walbrook is one of the improvements contemplated, in conjunction with purchasing and making free Southwark Bridge. But street-widening in the City is like buying gold. It is estimated that widening the narrow gut of the Poultry would cost £643,000: the net loss on purchasing property for widening streets is calculated at 50 per cent. It would cost £600,000 to open Waterloo Bridge, and £300,000 to open Southwark Bridge.

Mr. Thwaites is naturally anxious to secure an income for the Metropolitan Board over which he presides, in order to execute ornamental and useful improvements. If the Board is to be maintained in a regular manner, that is essential; but Parliament will probably wait to see how the Board does the work in hand before it assigns permanent revenues for its use. Mr. Thwaites points out that hired horses and carriages, including cabs and omnibuses, contribute more than half a million in duties to the National Exchequer, being within £5000 a year of the taxes of all the rest of England put together, and £80,000 a year in special taxes, which are not paid at all in other towns. The coal-tax he defends in London on the ground that it is a fair income-tax, amounting to not more than from 2s. 2d. to 2s. 8d. a year on the labouring man; and claims it from the inhabitants within the radius of twenty miles round London, on the ground that property and produce are raised in value by vicinity to the metropolis.

In addition to the three plans of Thames Embankment, the designs and some of the details of which have been engraved and attached to the report, the following parties suggested ideas or plans not in sufficient detail for execution: Mr. Lionel Gisborne, Mr. Brooks, Mr. Bird, and Mr. Edmeston. Some of these were very wild indeed; and others, quite unsuited for present wants, had been roughly altered and furbished up in a hurry. There can be no question, after reading the evidence, that the committee selected the three best and only practicable plans. They are all three based on one originally proposed by Mr. Page, who also gave evidence in 1848, and then first suggested meeting the claims from wharfingers for compensation by constructing docks. The following wharfingers opposed the embankment—Messrs. Berridge, Gould, Graham, Ledger, Anderson, White, all taking the narrow personal views common to the opponents of public improvements; and, although really only meaning compensation, to which for actual damage they were undoubtedly entitled, they were unanimous in stolid resistance to this inevitable reform of the river. We had a right to expect more enlightened views from the Lord Mayor in prospect, Alderman and Major George Anderson Rose. Mr. Kennard, M.P., with Mr. Radley and Mr. Harvey, are in favour of the embankment, without, of course, resigning their claim to compensation.

Ignorant opposition to improvement bills never dies. Less than ten years ago, the respectable and wealthy bankers, brokers, and shopkeepers of Clapham Common protested, at a public meeting, against a Railroad through that suburb, on the ground "that the navigators would debauch their maid-servants, and the roll of the trains turn the beer sour in their cellars!" The committee on the Thames Embankment, including men of great railway experience, seeing the class of evidence to be dealt with, wisely reported in favour of assessing the damage to wharfingers after the execution of the work. Mr. T. E. Harrison, the engineer, gave, as the result of his experience on the Tyne, in a work of the kind, that the transfer of goods from barges across the embankment, while in progress, could be satisfactorily and economically effected by the contractors for the embankment. It is well known that railway and water companies have paid enormous sums for the imaginary injury called "severance." If it should turn out, as is probable, that the wharve property will let for more money after the docks are made than before, one large item of compensation will be removed. One of the engineer witnesses proposes that the claims for compensation be settled by a commission, instead of a series of juries; a suggestion worth consideration, if competent commissioners could be secured.

The evidence would not have been complete without one witness altogether opposed to an embankment and narrowing of the river channel, "on hydraulic grounds." This witness was found in Captain William Maugham, who is not an engineer; on the contrary, he differs altogether from all the engineers who have executed great hydraulic works, gave evidence that narrowing the river between Westminster and Blackfriars, and cutting off the shallow mud-banks, would deepen the channel, and assist in removing obstructive shoals. Captain Maugham had, for twenty-one years, charge of the London Docks, and "has come to the conclusion that all embankments of rivers are injurious," and that the embankment from Chelsea to the Houses of Parliament is "a robbery out of the Thames." From a complete embankment he dreads injury in lowering tides at the London Docks. His evidence does not seem to have created any sensation beyond amusement. It reminds one of the famous passage in Captains Vetch and Washington's report on the Norfolk Estuary Bill: "We believe that, in many cases, a channel with gentle curves conveys the water faster than a straight channel. Nature has always preferred curved channels for her watercourses to straight ones; and it is but reasonable to assume that there is good cause and physical law why it is so." We are glad to see, from his evidence before the Thames Embankment Committee that Captain Vetch, who is, comic as it may sound, "Engineer appointed by the Admiralty, for the conservancy of the tidal waters of the United Kindom," in virtue of his natural abilities, it is to be presumed, as displayed in the above-quoted report, has improved a little since the date of that report, if we may judge from certain truisms contained in a report to the Admiralty, which he himself quotes with the sublime satisfaction of a schoolboy who has at last learned his lesson; as, for instance, it is "an axiom in hydraulics, that in any channel abrupt contractions and expansions impede the flow and impair the momentum of the stream;" and "that the velocity of the stream and its scour are mainly dependent on the depth." Conceive the gravity with which the eminent engineers and contractors on the committee listened to these quotations from "Scientific Dialogues for the use of boys from twelve to fourteen years old!" We cannot help dreading the much-needed Commissions and Commissioners for Arterial Drainage with the prospect of Captain Vetch, R.E., for a leading light and adviser.

THE LATE MR. JOSEPH LOCKE, M.P.

In Mr. Locke, another of the great engineers who laid the foundation of the Locomotive Railway System, has been suddenly taken from us by a secret and unsuspected disease, when apparently in a state of health which seemed to ensure many years enjoyment of the fortune and position he had earned.

Joseph Locke, like his teacher, George Stephenson, and his fellow-pupil, Robert Stephenson, was the son of a working man, learned his business as a mechanic at the bench, and, like all our greatest Engineers, owed his scientific education to his own exertions after he had actually commenced his apprenticeship. He was born in 1805, at Attercliffe, a village near Sheffield. We believe that his father was a working Engineer, and that his uncle was the William Locke, who worked as breaksman at the coal-pit near Newcastle with George Stephenson. According to the memoirs in Dod's Parliamentary Guide, he was educated at the Barnsley Grammar School; but this could scarcely have been education in the modern sense of the term as applied to an Engineer, for he was apprenticed at sixteen to George Stephenson, who was then a local colliery viewer, and had commenced the survey of his first Railway, the Stockton and Darlington. When George Stephenson was engaged to make the Manchester and Liverpool Railway, he selected Locke as one of his three resident engineers; and when Mr. Walker, the Government Engineer, and Mr. Rastrick, an engine-builder, reported against Locomotive and in favour of Stationary Power, Mr. Locke, in conjunction with Mr. Robert Stephenson, prepared the pamphlet in reply, which induced the Directors to give the "new wild scheme" the fair trial that ended in the complete triumph of genius over commonplace caution. From that time Mr. Locke's position was settled and his success certain. His name was associated with Mr. Stephenson's in the construction of the Manchester and Liverpool Line, and he was not the man to neglect opportunities of learning his profession, or of applying his knowledge when learned. He was engaged in making the line between Liverpool and Birmingham, and eventually became the Engineer-in-chief of it as the Grand Junction, one of the chiefest and best-paying lines in the kingdom. To enumerate his other works, which are so well known to the railway world, would be useless. He had a large share in introducing Railways into France, and while engaged upon them, he fought and beat the Government establishment of engineers, who were desirous of discrediting

all work not designed by the highly educated theorists of the Polytechnic School. The story of the attempt of the engineers of the *Ponts et Chaussées* to throw down one of Mr. Locke's bridges on the Paris and Rouen line by loads of wet sand, is a very amusing instance of official jealousy. With his usual courage, Mr. Locke denounced this conspiracy at a public dinner at Rouen. A thorough knowledge of the details of his profession, great energy, tact, and courage, were more leading points in Mr. Locke's career as an Engineer, than any remarkable scientific superiority. He was a good witness—clear, decided, yet cautious; and he appeared to advantage when taking the chair at the meetings of the Institute of Civil Engineers, for he encouraged the timid who had anything to say worth hearing, yet very decidedly put down irregular or useless talk.

He entered Parliament for Honiton, where he possessed a large property, in 1847, on the liberal interest, but seldom spoke except on professional subjects. When first elected, he was a very indifferent speaker, nervous, hesitating, and confused; but, with characteristic energy, he set to work to learn this new business, and by constant practice, sometimes at the expense of his friends, at social and scientific meetings, he very soon became a fluent and effective speaker. Mr. Locke's appearance was eminently gentlemanly and very youthful until, by the fall of a platform while inspecting a tunnel in France, he sustained severe injuries, including compound fracture of one leg. No one could have suspected, from Mr. Locke's appearance and manners, in how humble a condition he had been bred and born. There is an excellent portrait of him engraved, from a picture by Mr. F. Grant, R.A. To the last, he continued in the active practice of his profession, in conjunction with his partner, Mr. Errington, and is supposed to have left a very large fortune.

Circular to Gas Companies.

There is no question so prolific of disputes and dissatisfaction between gas companies and the public as the supply of gas to street lamps, because (in the absence of any accurate means of measurement), the quantity consumed being always liable to vary with the pressure at the works, and still more with the judgment and will of the lamplighter, this uncertainty affords an ever-ready handle to those who are on the look out for grievances to excite discontent and to get up complaints against the companies of deficiency in the supply. During the metropolis gas agitation, this was one of the most telling charges against the companies, and on which the agitators strongly relied as a means of inducing the vestries to vote away the public money to defray their expenses. It was affirmed by Mr. Hughes that the London vestries and district boards were thus defrauded to the amount of upwards of £50,000, and he founded that assertion on some experiments he had made on a few of the street lamps in Westminster and Chelsea, according to which it appeared that the quantity of gas consumed was 30 per cent. less than the quantity contracted for. Elaborate tables, concocted by Mr. Hughes, were presented to the committee on the Metropolis Gas Bill, and are printed in pages 108 and following pages of the blue book containing the evidence, in which the particulars of the alleged frauds are duly specified, and the overcharges in each parish are set forth, amounting together to the sum of £50,638 per annum. At the time this impudent charge of fraud against the gas companies was originally made we exposed its fallacy, and published a statement in a tabular form, compiled from official sources, wherein it was clearly shown that, instead of an overcharge of £50,638; there was actually an undercharge to the amount of £32,240 per annum.

The metropolitan gas companies naturally felt highly indignant at the imputation on their honesty, and were prepared with ample proofs to refute the gross accusation, but they were prevented from doing so by the chairman of the committee, who interrupted Mr. Beck, the deputy-governor of the Chartered Company, when giving his evidence, to observe that the committee would not receive evidence to rebut what had been said on the other side affecting the character of the companies, as it was a matter with which they had nothing to do, and that he did not consider that anything that had been laid before them did affect their character. This decision of the chairman was felt at the time to be scarcely fair to those against whom the charges of fraud had been openly made at vestry meetings, in the public papers, and in the committee room; for, though it was satisfactory to know that such charges had made no unfavourable impression on the minds of the committee, they might have produced an effect elsewhere.

As an exemplification of the complete answer with which the companies were prepared to refute the accusation of not fulfilling their contracts, we now publish the results of thirty-seven experiments made in January last, under the superintendence of Mr. Hawksley, to ascertain the actual consumption of gas in the street lamps in Greenwich, Lewisham, and Charlton. It was represented by Mr. Hughes, in the tables he laid before the committee, that the public were robbed by the Phœnix Company, which supplies those parishes, to the extent of nearly £2000 a year; that, instead of £4. 15s. per lamp, the sum of £2. 8s. 3d. should have been paid to the company for the quantity of gas supplied; and that the overcharge for each lamp was £2. 6s. 9d. per annum. It will be seen by the subjoined experiments, in conducting which every possible precaution was taken to obtain correct results, that, so far from the consumption being only three feet and a half per hour, as stated by Mr. Hughes, the actual average quantity consumed by thirty-seven lamps, at different altitudes, and at various distances from the works, was but a fraction less than six feet per lamp per hour; so that the consumption was actually 20 *per cent. more* than the quantity contracted for, instead of being 30 per cent. less.

These experiments possess an intrinsic value, independent of the special object for which they were undertaken. They form, as Mr. Hawksley observes, "the most perfect series of experiments of this nature that have been hitherto made," and afford much curious and interesting information respecting the issue of gas from the same burners during the fluctuations of the night's pressure, at heights varying from 4 feet below the level of the works to 139 feet above it, and at distances extending from 440 yards to 6720 yards in a straight line.

In conducting these experiments, the precaution was adopted of placing a small piece of tube round the orifices of the burners, so as to prevent obstruction to the issue of the gas by the pressure of the covering. There is good reason to believe that the extraordinary results obtained by some persons in their experiments with street lamps were owing to their having neglected this precaution; and that by drawing the flexible tube directly over the burner, the gas was choked, and prevented from escaping so freely as when it is lighted.

A very curious fact came to light in the course of the experiments which requires especial notice. It might have been supposed, as the gas had to pass through meters to be registered, that the friction of the meters would have considerably checked the flow, and that the quantity registered would have been less than the quantity consumed when burning freely; but, on instituting a series of experiments to determine the correction to be made as compensation for the difference between the consumption of gas when lighted and when not lighted, and the friction of the meter, it was found that the quantity consumed when burning freely was not so great as when the unlighted gas passed through the burner and overcome the friction of the meter afterwards. This anomalous result, apparently so opposed to preconceived notions of the effect of resistance, was ascertained to be owing to the heating of the gas before it issued through the hot burner. The heating of the gas of course increases its bulk; and, the volume being increased, it requires more time to pass.

To the Directors of the Phœnix Gaslight and Coke Company.

Gentlemen,—In January last, I received instructions from you to make a series of observations upon the street lamps in the district supplied from your Greenwich works, with the view of ascertaining the quantity of gas consumed by each of them during the different hours of the night; but as it would have occupied too much time to experiment upon every one of the 609 lamps of the district, it was necessary to select a fair average of the whole in respect of their distance from, and their altitude as compared with, the works, and with this view 37 lamps were selected, and their consumption of gas ascertained on seven different nights—viz.: Three on Jan. 17; six on Jan. 19; six on Jan. 21; six on Jan. 23; six on Jan. 25; five on Jan. 28; five on Jan. 30.

The lamps experimented upon on each night were selected before the lamplighters commenced lighting them, and due care was taken to prevent the situation of the lamps to be tested on any night coming to the knowledge of your agents or servants.

For the purposes of these experiments, I procured from Messrs. W. Parkinson and Co. six carefully-adjusted experimental meters, with the apparatus necessary for attaching them to the lamp-irons after the lamplighter had performed his duties. The flames were then blown out, and by pieces of flexible tubes the gas which passed through the burners was conducted into the meters and the hourly registration noted till the lamp-cock was closed by the lamplighter in the morning.

The situation of each lamp is marked in the accompanying plan of the district.

After the experiments were terminated, it became necessary to institute another series, in order to determine the correction to be made in the recorded registration of the meters, to compensate for the difference between the con-

sumption of a burner when lighted and its consumption when not lighted, and also for the friction of the meters. The tables, Nos. 1 and 2, hereunto annexed, give the corrected consumption of gas by the burners when lighted together, with such other information as is required in order to form a correct opinion as to the conditions and state of the supply. The result is that the *minimum* consumption of the 37 burners tested is within a fraction of 5 cubic feet per hour, and the *average* within a fraction of 6 cubic feet per hour, while the *maximum* is a trifle over 7 cubic feet per hour.

I have examined the pressure-register papers of the corresponding period of last year, and find that the initial pressure given from the works has not been sensibly increased this year.

The details of these experiments were conducted by Mr. Thomas G. Barlow and Mr. Gilderdale Parkinson, under my direction and personal supervision, and I believe they form the most perfect series of experiments of this nature which have hitherto been made.

I am, gentlemen, your obedient servant,

T. HAWKSLEY.

30, *Great George Street, Westminster, May* 9, 1860.

TABLE No. I.—*Observations on the Consumption of Gas by the Public Lamps in Greenwich, Lewisham, and Charlton, supplied by the Phœnix Gas Company, from the Greenwich Station, in January*, 1860.

Number of the Lamp on the Plan.	Date when the Observation was made.	Altitude of the Street in Feet above the Entrance to the Gas-works.	Distance of Lamp in Yards on a Straight Line from the Entrance to the Gas-works.	Time at which the Lamp was Lighted.	Time at which the Observation commenced.	Time at which the Lamp was Extinguished.	Time occupied by the Observation.	Quantity of Gas in Cubic Feet Consumed by the Lamp during the Observation.	Quantity of Gas in Cubic Feet Consumed per Hour during the Observation.			Pressure in the Mains in Tenths of an Inch.	
									Maximum.	Minimum.	Average.	Maximum.	Minimum.
		Ft. in.		h. m.	h. m.	h. m.	h. m.						
1	Jan. 17.	5 0	1450	About 4.15	5.33 P.M.	7.26 A.M.	13.53	67·75	6·08	3·40	4·87		
2	" "	7 0	1670	About 4.30	5.15	7.20	14. 5	64·87	5·49	4·04	4·60		
3	" "	3 10	2090	About 4.15	5. 0	7.30	1—13.12	59·74	5·96	3·38	4·53	21·5	9·5
4	Jan. 19.	6 0	1090	4.55	6. 0	7.56	13.56	77·47	7·91	4·05	5·67		
5	" "	3 10	1190	4.45	6.48	2.37	2— 7.49	54·89	8·75	4·71	7·02		
6	" "	Level.	750	5.30	6. 9	7. 9	13. 0	67·83	6·57	4·23	5·22		
7	" "	4 0 below.	440	5.15	6.26	7.30	13. 4	55·46	5·30	3·49	4·24		
8	" "	Level.	940	4.45	5.28	7.18	3—12. 8	93·96	10·80	6·78	7·74	21· 0	9· 0
9	" "	5 0	1180	4.45	8.31	7.26	10.55	73·92	7·55	5·01	5·91		
10	Jan. 21.	10 0	2330	4.50	5.10	6.59	13.49	67·42	5·84	3·93	4·88		
11	" "	2 6	2365	5. 0	5.16	8. 8	14.52	64·34	6·13	3·60	4·33	20·	11·
12	" "	Level.	2695	5.10	5.21	8.12	14.51	85·47	6·61	4·88	5·76		
13	" "	2 0 below.	2800	5.15	5.47	6.51	13. 4	91·71	7·98	5·76	7·02		
14	" "	1 0	2980	5.15	5.59	6.44	12.45	69·17	6·26	4·41	5·42		
15	" "	6 0	2380	5.30	7.10	6.57	11. 7	47·41	4·82	3·29	4·27		
16	Jan. 23.	19 6	1485	5.15	5.48	7.20	13.32	69·61	7·15	3·19	5·14		
17	" "	22 0	1606	5.20	5.56	7.19	13.23	80·64	7·09	4·30	6·03		
18	" "	39 0	1870	4.55	5. 8	7.12	14. 4	59·61	4·68	3·33	4·24	22·	13·
19	" "	35 0	1914		7. 7	6.30	11.23	83·99	8·10	6·59	7·38		
20	" "	29 8	1740	5.20	5.37	7.19	13.42	77·43	6·54	4·76	5·66		
21	" "	30 7	1650	5.35	5.20	7.32	13.12	69·19	6·04	4·42	5·23		
22	Jan. 25.	29 5	2160	5.15	5.49	6.40	12.51	77·91	7·38	4·80	6·06		
23	" "	75 0	2160	4.45	5.35	6.55	13.20	60·65	5·11	3·90	4·55	20·	11·
24	" "	41 9	2400	5. 0	5.59	6.40	12.41	38·34	3·35	2·30	3·02		
25	" "	27 7	2235	5. 0	6. 6	6.45	12.39	84·01	8·14	4·96	6·50		
26	" "	53 1	2980	5.30	6.15	7.30	13.15	79·24	6·98	4·48	5·98		
27	" "	28 0	2510	5. 0	6.43	6.36	11.53	50·81	5·02	3·60	4·27		
28	Jan. 28.	137 5	2610	About 5. 0	5.32	6.43	4—11.11	91·94	8·78	7·73	8·21	27·	22·
29	" "	139 0	3025	About 5. 0	6. 3	7.30	13.27	96·98	7·95	6·89	7·21		
30	" "	138 0	2805	About 5. 0	6. 8	7.28	13.10	97·57	8·10	6·92	7·41		
31	" "	137 10	2650	About 5. 0	6.19	6.41	12.22	99·22	8·51	7·58	8·02		
32	" "	137 0	2630	About 5. 0	6.40	7.26	12.46	92·87	7·92	6·97	7·28		
33	Jan. 30.	69 0	5590	5.30	5.43	6.50	13. 7	85·68	8·17	5·12	6·44	22·	10·5
34	" "	99 0	6050	About 5.30	6.28	7.15	12.47	115·67	10·96	8·16	9·08		
35	" "	87 0	5930	About 5.30	6.37	6.18	11.41	94·80	8·93	7·16	8·10		
36	" "	61 0	5735	About 5.30	6.45	6.20	11.35	78·43	7·31	5·93	6·76		
37	" "	47 0	6720	About 5.30	6.52	6.23	11.31	82·33	8·17	5·83	7·16		
							Mean consumption per hour.....		7·06	4·98	5·98		

Notes.—1. In lamp No. 3, 1 hour 18 minutes have to be deducted from the time occupied by the observation, in consequence of the plug having been accidentally left in the outlet of the meter after the pressure had been noted.

2. The meter of lamp No. 5 ceased to register at 2 hours 47 minutes A.M., in consequence of the flexible tube having become deranged.

3. In lamp No. 8, 2 hours 42 minutes have to be deducted for the same reason as in lamp No. 3.

4. In lamp No. 28, 2 hours have to be deducted from the same cause.

TABLE No. II.—*Observations on the Hourly Consumption of Gas by the Public Lamps in Greenwich, Lewisham, and Charlton, supplied by the Phœnix Gas Company, from the Greenwich Station, in January*, 1860.

Number of the Lamp on the Plan.	Date when the Observation was made.	Consumption of Gas per Hour by each Lamp.														
		6 P.M.	7	8	9	10	11	12	1 A.M.	2	3	4	5	6	7	8
1	Jan. 17..	5·60	**5·87**	5·87	6·03	6·08	5·63	5·36	4·69	4·14	4·07	3·93	3·89	4·41	4·11	
2	" "	4·86	**4·86**	4·04	4·28	4·46	4·59	5·49	5·22	4·46	4·50	4·46	4·44	4·95	4·71	
3	" "	5·96	...	5·72	5·63	5·63	5·22	4·91	4·28	3·67	3·38	3·32	3·40	3·70	3·78	
4	Jan. 19..		7·21	5·38	6·86	6·76	6·39	5·89	5·93	4·05	4·72	4·80	4·77	5·31	4·95	4·37
5	" "			8·75	8·70	8·28	7·74	7·12	6·12	5·06	4·71	...	...	...	...	
6	" "		6·41	6·29	6·57	6·27	5·81	5·30	4·50	4·37	4·23	4·38	4·30	4·95	4·40	
7	" "		5·14	5·18	5·39	4·98	4·69	4·40	3·71	3·72	3·49	3·60	3·58	4·00	3·51	
8	" "		10·27	10·21	10·80	...	9·32	8·34	7·16	7·16	6·92	7·20	...	8·06	6·78	
9	" "				7·35	7·31	6·65	6·09	5·28	5·26	5·19	5·31	**5·65**	5·65	5·01	
10	Jan. 21..	5·84	5·58	5·49	5·58	5·67	5·61	5·22	4·42	4·18	4·03	3·95	3·93	4·45	4·17	
11	" "	6·13	3·94	4·72	4·72	4·79	4·99	4·64	3·97	3·88	3·75	3·60	3·61	4·30	**4·30**	3·82
12	" "		6·61	6·36	6·37	6·54	6·55	6·60	6·17	5·22	5·17	5·03	4·93	4·96	5·67	4·88
13	" "		7·97	7·78	7·80	7·93	8·98	8·97	7·34	6·20	6·12	5·94	5·85	5·98	6·74	
14	" "		6·26	6·06	6·06	6·15	6·18	6·23	5·46	4·73	4·67	4·47	4·41	4·66	5·18	
15	" "			4·77	4·82	4·79	4·76	4·43	3·80	3·52	3·47	3·35	3·29	3·68	3·52	
16	Jan. 23..		6·93	6·81	7·10	7·15	6·61	4·56	3·95	3·90	3·36	4·30	3·66	4·03	3·19	
17	" "		6·84	6·66	7·07	7·09	6·69	6·06	5·53	6·49	5·39	5·22	5·46	5·74	4·30	
18	" "		4·47	4·27	4·49	4·68	4·66	4·33	4·07	4·08	3·97	3·87	4·05	4·14	3·33	
19	" "			8·10	7·73	7·95	8·06	8·01	7·24	6·79	6·89	6·60	6·59	7·00	8·06	
20	" "		6·32	6·26	6·47	6·54	6·04	6·02	4·98	5·12	5·17	4·76	5·14	5·40	4·88	
21	" "		5·64	5·76	5·95	6·04	5·84	5·49	4·84	4·86	4·74	4·59	4·79	4·42	5·21	
22	Jan. 25..		7·02	6·93	7·13	7·38	6·87	6·05	5·49	5·39	5·21	5·22	4·80	5·25	5·36	
23	" "		4·57	3·96	4·79	4·84	5·11	4·75	4·58	4·42	4·46	4·35	4·49	4·69	5·89	
24	" "		3·35	3·17	3·35	3·33	3·34	3·03	2·88	2·83	2·77	2·72	2·76	2·85	2·30	
25	" "		7·72	7·73	7·93	8·14	7·34	6·40	6·28	5·67	5·75	5·54	5·57	5·72	4·96	
26	" "			6·24	6·44	6·69	6·98	6·65	6·12	5·78	5·64	5·57	5·54	5·66	5·80	4·48
27	" "			4·91	4·74	4·96	5·02	4·66	4·15	4·01	3·84	3·60	3·68	3·86	3·89	
28	Jan. 28..		7·92	7·73	7·95	8·10	8·78	...	8·15	8·24	...	8·46	8·43	8·48	8·36	
29	" "		7·17	7·21	7·56	7·95	7·38	7·47	7·19	6·97	6·89	7·01	6·99	7·11	6·97	
30	" "		7·43	7·73	7·56	8·10	7·65	**7·38**	7·38	7·04	7·02	7·07	6·93	7·07	6·92	
31	" "		7·58	7·58	7·92	8·41	8·01	8·51	8·02	7·97	8·01	8·04	8·05	8·26	7·74	
32	" "		7·18	7·46	7·33	7·92	7·55	7·50	7·07	7·01	7·10	7·16	7·11	7·27	6·97	
33	Jan. 30..			6·55	6·81	7·24	7·72	8·17	7·03	6·37	6·15	5·98	5·61	5·67	5·12	
34	" "			8·16	8·61	9·11	10·96	10·62	9·78	9·18	8·83	8·72	8·65	9·20	8·43	
35	" "			7·16	7·60	7·94	8·63	8·93	8·25	8·14	8·22	8·13	8·12	8·58		
36	" "			5·93	6·39	6·66	7·31	7·22	6·86	6·78	6·77	6·72	6·85	7·28		
37	" "			5·83	6·31	6·78	7·83	8·17	7·42	7·24	7·29	7·19	7·28	7·75		
	Mean ...	5·67	6·41	5·85	6·60	6·62	6·68	6·36	5·76	5·51	5·33	5·36	5·33	5·68	5·22	4·38

Note.—The figures in black type are estimates of the consumption founded on nearest observations when the time between each was less than one hour. The dotted lines indicate the hours between which observations were not recorded, in consequence of the accidental derangement of the apparatus mentioned in the note to Table No. I.

In the summary, in our last number, of the Gas Acts of the past session, we gave only a passing glance at the Act for regulating the supply of gas to the metropolis, because most of its provisions had been previously discussed; but we have not yet sufficiently noticed the masterly manner in which the case of the gas companies was conducted by their professional agents. It must be admitted that their opponents had some strong points to urge in favour of the adoption of stringent measures to control the virtual monopoly acquired by the companies; and, in one or two instances, by indiscreet exercise of power, they had rendered themselves unpopular even with those who viewed the general question without prejudice. A monopoly of any kind is repugnant to English feeling, and it is very up-hill work to plead the cause of monopolists even in committees of the Houses of Parliament. The promoters of the Metropolis Gas Regulation Bill came provided with a list of grievances, which they had assiduously collected from all quarters; they had two years experience in the previous parliamentary inquiries to guide them in bringing their evidence to bear with best effect, and they appealed to Parliament to protect the gas consumers of London against the tyranny of an organized body who had, as alleged, illegally usurped exclusive power to supply one of the necessaries of life. Though the gas companies had good answers to all the charges brought against them, their case was to be judged by a committee open to popular influences, who were ignorant of the matters to be discussed, and therefore liable to be misled by popular prejudice. The vacillating conduct of the committee of the Commons, as the counsel on either side addressed them, showed that little dependence could be placed on their judgment; and when, at the suggestion of the promoters of the bill, they proposed to emasculate the Gas-Works Clauses Act, and to reduce the prescribed dividends from 10 per cent. to 6, the professional agents of the companies sounded a retreat, and left the field entirely to their opponents. The policy of that retreat was much questioned at the time, but events proved that it was the manœuvre of accomplished tacticians. The promoters of the bill, in their eagerness to take advantage of their position, outran discretion, and induced the committee to introduce confiscating clauses, that would not only have ruined the property of the metropolitan gas companies, but would have endangered the property of all public companies. By thus throwing aside the show of justice, they raised enemies in all directions, and the sympathies of the joint-stock interest in all parts of the country were excited in favour of the London gas companies. This feeling was so strongly pronounced in the House of Commons, that the chairman of the committee requested that they might be allowed to reconsider their report. The eyes of the committee having been thus opened to the designs of the parochial delegates, they allowed themselves to be guided by the plain persuasive eloquence of the parliamentary agent of the companies, unaided by counsel, and expunging the confiscating clauses, they made amendments which placed the gas companies in a much better position than they might have been had the promoters been kept in check in the first instance, and not have been permitted to run riot, as they did after the retreat of their opponents. The stratagem, "*reculer pour mieux sauter*," was seldom practised more successfully than by the skilful legal generals who led the banded London gas companies through the committee room of the House of Commons.

Now that the struggle is ended, and we reconsider at leisure the provisions of the Metropolis Gas Regulation Act with a view to their practical operation, it seems probable that the testing clause may give rise to some difficulty, if the rigid test for ammonia be strictly adhered to. It has been recently ascertained that gas, practically free from ammonia when in the gasholder, absorbs it in passing through the mains, in which it may have been deposited a long time. The old mains of most of the gas companies are probably in that condition, and gas passing through them may be contaminated with ammonia for years to come. If that should occur to such an extent that the gas will not bear the test prescribed by the Act without discolouring the test-paper, the gas companies will be awkwardly situated. The local authorities, if inclined to be vexatious, might, in such case, proceed against them for penalties, and for the payment of the additional £10 for every day that the impurity continues. It would then be for the police magistrates to decide whether the subsequent contamination of the gas in the mains was not an "unavoidable cause" of defect, so as to exonerate the companies. Another solution of the difficulty may be found by taking advantage of the proviso which gives the local authorities the power to agree with the companies to adopt "any other or different test," or "to vary the amounts of ammonia or sulphur" allowed; and if it be satisfactorily proved that the gas at the works possesses the required purity, the local authorities must be very obstructive and vexatious, if they refuse to make such an arrangement as contemplated in the proviso.

The public authorities of Bristol have discovered that the solution of their differences with the gas company in respect of the price to be paid for the street lamps, upon which we commented in our last, lacks even the pennyworth of wisdom we were at first disposed to accord to it; and further negotiations have ensued, which have terminated in the acceptance of the company's offer for two years, instead of for three years, as originally proposed by them. Upon calculating the quantity of gas consumed in a year by a 4-feet burner, reckoning from the time of its being lighted to the time of its being extinguished, it was found that, at the lowest rate charged to any private consumer, the cost would have been 1s. 8d. per lamp more than the sum at which the company tendered for 5-feet burners, a discovery which seems to have staggered even the Ratepayers Protection Association, to whom the dismal prospect of 30 per cent. less light, with 2 per cent. increase in the charge, cannot have been very encouraging, or have afforded any very tempting premium for further agitation in the same direction. As might have been expected under such circumstances, the compromise considerately offered by the gas company was unanimously accepted by the authorities; and, before they have again to consider the question, they may perhaps have arrived at a more correct appreciation of their rights and obligations than they at present entertain; for, with the exception of Mr. Herapath and a few other members, the Bristol Parliament appears to conceive very exaggerated notions of its powers. "We," according to Mr. Warren, "confer a monopoly on the gas company, and in return for the immense profit they make out of it, they owe a duty to the corporation, and their careful aim should be to light the city at a reasonable rate." Mr. Warren, who is evidently well acquainted with the doings of the metropolitan gas delegates, ought to have known that the body to whom this was addressed had neither power to confer a monopoly or to create competition in the supply of gas. The Imperial Legislature reserves to itself the granting of all such powers; and, as we have often before observed, since the passing of the Gas-Works Clauses Consolidation Act in 1847, no new gas company has been authorized by Parliament to enter into competition with any existing gas company which had adopted that Act, as the Bristol Company did in 1853. In some other respects, also, Mr. Warren's information is at fault. He talks about the cost of public lighting in Manchester being less than it is in Bristol, omitting from his statement the expenses of lighting, extinguishing, cleaning, and repairing the lamps, which are paid for in addition to the amount appearing in the corporation accounts as paid for gas, and which expenses may be put down in round figures at £4000 a year, and he forgets, also, that the consumption of each lamp is in Manchester only 2¾ cubic feet per hour!

The crowded state of our columns has hitherto prevented our inserting a report made some months since to the New River Company, by Mr. Spencer, on the effect upon their mains of the leakage from the gas-mains. The subject is an important one to all parties, but the remedy he proposes for the evil in the metropolis is, we fear, an impracticable one, and even if practicable, a very imperfect one. Turned and bored pipes have been tried by several of the gas companies of the metropolis, and have been abandoned in consequence of their extreme rigidity, the effect of which in the loose subsoil, and with the heavy traffic of the London streets, has been to cause endless cracks and fractures in the pipes, and an increase rather than a decrease in the leakage. Mr. Innes, the engineer of the Phœnix Gas Company, stated in his evidence on the Metropolis Gas Bill, that he had taken up 30 or 40 miles of these pipes on this account, and his experience has been confirmed by that of the engineers of other metropolitan gas companies. In towns where the ground is more solid and less liable to be disturbed, and where the traffic is of a lighter character, such pipes have been found to answer well; but there are exceptions to most rules, and the metropolis certainly is one to the ordinary conditions of the thoroughfares of our largest cities.

Several corrections in our last quarterly Gas and Water Share Lists arrived too late for insertion in the last lists, and

as we purpose reprinting them in our next, we shall be obliged by our readers advising us before the 6th proximo of any changes that have taken place, either in the paid-up capitals, dividends, or value of shares since the publication of the last lists on July 17.

Register of New Patents.

627.—Christophe François Delabarre, a Knight of the Legion of Honour and C.E., of Neuilly, near Paris, for "*Improved apparatus to be used in propelling gases and forcing liquids.*" Provisional protection only obtained, dated March 8, 1860.

This invention being improvements on a former invention of the patentees (letters patent dated, 15th February, 1855, No. 346), consists of certain mechanical arrangements, or apparatus by which gases or liquids may be acted on by attraction or propulsion, and this method is used to force water into steam generators or boilers, in place of pumps as at present employed, and also in the blowing apparatus described in the before mentioned patent.

These additional improvements in propelling gases, and forcing liquids into any medium whatever, consists of various modifications of the said apparatus, so as to render it capable of receiving, or attracting a column of water, liquid, air, or any elastic gas, and directing this column against a medium or any pressure that may be desired, the said attraction or direction of water, liquid, air, or elastic gas, being performed through the agency of one or more jet or jets, stream or streams of steam, or other elastic fluid, through a pipe or pipes, tube or tubes. These jets or streams are directed into a tubular space, into which the water, liquid, air or elastic gas enters either by partial vacuum created by the jets or streams or by head pressure, and in either of these cases is propelled with great dynamic momentum against any statical pressure of any power that it may be desired to overcome, and against which the water, liquid, air, or elastic gas has to be forced. The particular arrangements and combinations of steam, water, liquid, air, or elastic gas-pipes of suitable bores and dimensions, air-holes, cocks, valves, &c., constitute this part of the present improvements on the corresponding parts of the before mentioned patent. The apparatus hereinbefore described for forcing liquids into steam generators or boilers, is also made self-acting, by combining with it a float actuated by a rack and pinion, or other mechanical arrangements.

The second part of the present improvements, consists of various modifications in the position, shape, and relative dimensions of the blowing apparatus before referred to. These modifications consist in applying two blowing apparatuses, one at each side, whenever the grate or furnace is of some considerable length. The blowers may be also directed so as to act upon the top surface of the fire. Instead of placing the apparatus so as to blow in a horizontal direction, it is so fixed as to act at any desired angle, either under or above the grate or furnace.

The change in the relative dimensions consists in so contriving the apparatus, that a greater or lesser quantity of air may be admitted, as compared with the quantity of steam, or other elastic fluids or gas, according to the nature of fuel used, or the construction of the furnace.

The object of the modifications as relates to the shape of the blowing apparatus, is partly to render the same more portable, as well as at the same time to afford greater facilities for fixing it.

635.—George Shearman, of Haggerston, in the co. of Middlesex, gas-meter manufacturer, for "*Improvements in water gas-meters.*" Patent dated, March 8, 1860.

The object of the improvements is a more correct working of wet gas-meters. For this purpose, the float is controlled to act in a separate compartment of the front chamber formed by partitions dipping to below the water-line of such chamber. An opening is formed in the upper part of this compartment for the passage of air, and the gas is excluded from this compartment, except when from any cause the level of the water falls below its lower edges. The float is by connexions attached to a valve, capable of closing the inlet passage, as also to a conical or other suitable valve adapted to regulate the quantity of gas passing into the measuring compartment of the meter when undue pressure is exerted, and the float is also connected to another valve capable of closing the passage for the atmosphere to this compartment when from undue pressure of the gas the float has a tendency to be raised above a certain height, and sometimes a pipe is applied to such opening.

In place of forming a separate compartment in the front chamber for the float, the float may be placed in the case for the measuring drum of the meter, and thence by suitable connexions attached to the valves.

Secondly, the improvements relate to arranging the parts supporting the measuring drum, that when the meter is tilted such drum shall come forward and act to close the passage of gas through the meter.

677.—James Sim, of Aberdeen, N.B., manufacturing chemist, for "*Improvements in measuring and registering the flow or discharge of liquids.*" Patent dated March 14, 1860.

This invention relates to the adaptation and use of ordinary gas-meters or other fluid or liquid measuring and registering apparatus in the measuring and registering the flow and discharge of liquids under various circumstances and under various conditions; and it bears importantly upon an invention of improvements in measuring and registering the flow or discharge of liquids, for which the present patentee applied for letters patent on the 25th November last (No. 2669). The provisional specification of that invention describes the improvements as consisting in the adaptation of a wet gas-meter, or other fluid meter to the measurement and registering of the flow or discharge of liquids, by causing the atmospheric air necessary for supplying the vacuum created by the withdrawal of any liquid from a cask or reservoir, to pass through the said meter. and thus negatively measure and register the quantity of liquid drawn off. According to the present invention the meter still measures and registers the quantity of liquid drawn from any receptacle, but it is through the medium of the air dislodged from another cask or receptacle by the admission of the negatively measured liquid thereto. The meter, which it is preferred to use for the purpose, is a modification of the ordinary gas or air-meter, and is so arranged as to measure the quantity of air passed through it, and register the same in liquid measure or gallons, and aliquot parts thereof.

The claim is for the system or mode of measuring and registering the quantity of liquid conveyed into a cask or other closed vessel by means of the volume of air which is expelled from the cask or other closed vessel, and is caused to actuate the mechanism of a meter, and so register the quantity of liquid conveyed into the receiving-vessel; also the system or mode of measuring and registering the quantity of liquid at and to a stock-cask or vessel by means of the displaced air, the quantity of which passing through the meter indicates the number of gallons or other quantities contained in it.

678.—James Sim, of Aberdeen, N.B., manufacturing chemist, for "*Improvements in meters or apparatus for measuring fluids.*" Provisional protection only obtained. Dated March 14, 1860.

This invention relates to the arrangement and construction of meters of the wet class so as to obtain a correct measurement of the gaseous fluid which is passed through it, irrespective of the height of the water in the meter, or whether it is out of the level. Under one modification the measuring-drum or cylinder is made with a solid central disc, through which the supporting spindle passes. The outer part of the drum is formed of plates, diverging angularly from the periphery of the central disc, these recesses forming the measuring-chambers. The inlet-pipe enters in the usual way, parallel to the axis of the drum, and is then bent upwards, extending to the water-line; the outlet-pipe is arranged in the ordinary manner at the upper part of the meter.

Another mode of arranging and constructing the measuring-drum consists in forming an air-chamber at the centre of the drum, in lieu of the solid vertical diaphragm. This air-chamber is a sealed horizontal cylinder, and is of sufficient capacity to float the measuring-drum, and so cause it to turn upon its axis with little or no friction. To the periphery of the central air-chamber are fastened the diverging plates which form the triangularly-shaped measuring-chambers. In fitting up meters for measuring gas it is preferred to divide the upper part of the front box of the meter by means of partitions. In the upper compartment is placed a worm or helical bent tube, which communicates with the outlet-pipe. This worm or bent tube is for the purpose of causing the gas, as it passes away to the outlet, to deposit the water, which it carries off in its passage through the meter, and so prevent the flickering of the lights, which arises from the moisture collected in the bends of the service-pipes. The lower end of the worm tube passes through the partition in the front box, and the gas, after being measured, passes into the front box through an opening made for the purpose below the partition, and away by the helical tube.

The meter is supplied with water through an opening near the outlet-pipe. The water fills the compartment in which the worm is fitted, and then passes down the tube which encloses the spindle of the index and into the lower part of the meter. The surplus water passes off by the inlet-pipe at the eye of the measuring-drum, and along a syphon bend to the outside of the meter. The whole or part of this modification may be advantageously applied to meters for measuring liquids as well as to meters which are in ordinary use for the measuring of gas.

681.—William Thomas Cheetham, of Rochdale, Lancaster, mechanical draughtsman, for "*Improvements in cocks or taps.*" Provisional protection only obtained. Dated March 14, 1860.

This invention relates to the construction of self-shutting cocks or taps. The valve or other such apparatus, which regulates the supply, is connected to a piston or its equivalent, which, when the valve is being closed by pressure of the fluids, acts by a tendency to compression upon the fluid, which can only pass through a contracted aperture or apertures, thereby preventing a sudden closing. This is done by the piston moving upwards or downwards or horizontally, and the said apertures may be in the piston or in the cylinder thereof. The escape of the fluid is so shaped that there shall be a decreasing area as the valve approaches its seat. The piston above mentioned can be established in equilibrium by admitting pressure around it, and the same effect is also gained by an equilibrium valve. Another arrangement of self-closing cock or tap consists in mounting the valve upon a screw, the thread of which is sufficient to give way to the pressure of the fluid.

712.—Thomas Richardson, of Newcastle-on-Tyne, and Manning Prentice, of Stowmarket, for "*Improvements in the manufacture of hydrated oxides, and salts of iron, and salts of the fixed alkalies.*" Patent dated March 17, 1860.

This invention consists in submitting oxides of iron to the action of sulphurous acid, and exposing the solution to the atmosphere to obtain hydrated oxides of iron and sulphate of iron.

The invention also consists in decomposing such solution by muriate of soda or potash to obtain corresponding alkaline salts, and also muriate of iron; from which muriate of iron hydrated oxide of iron may be precipitated by lime, magnesia or baryta or their carbonates.

The apparatus employed in carrying out this invention consists of arrangements of condensing-towers, such as are in ordinary use for condensing muriatic acid; but instead of filling them with coke or fire-bricks, the burnt pyrites, which is now a waste product in chemical works, is employed. As the oxide of iron dissolves out, the insoluble portion has a tendency to choke the column. The interior is therefore divided every few feet by means of stone shelving perforated with holes to admit the passage of the gases and liquids. Openings are formed through the towers to coincide with the floors or horizontal partitions, and these openings are closed by suitable doors. The towers thus modified in their interior construction and filled with burnt pyrites, are supplied with a stream of water, which in falling meets a current of sulphurous acid, which may be obtained from those sulphurous ores which are too poor for the use of sulphuric acid makers, and which may be burned in small open fires or furnaces of the simplest construction. The sulphurous acid is partially oxydized at the expense of part of the oxygen of the burn pyrites, and the oxides of iron dissolved in the acid liquid. The solution on exposure to the air, either before or during concentration, furnishes a hydrated precipitated oxide of iron, well adapted for the purification of

coal gas, or as a manure to act as a purveyor of oxygen to the land. When the liquor from the condenser has acquired a strength of about 40° Twaddell, it is concentrated and set aside for the crystallization of ordinary green copperas.

Instead of using water the condensing-tower is supplied with a solution of muriate of potash or soda at about 15° Twaddell, and the operation is conducted as already described until the solution of the mixed salts stands at 50° Twaddell. The liquids obtained from the column are boiled nearly to dryness, and the salts which crystallize out are separated. The mother liquid contains the muriate of iron, which may be employed in this state, or it is dried up with sawdust, and the mixture is employed in purifying gas or liquors containing sulphur compounds, or it is previously mixed with an equivalent quantity of lime, magnesia, baryta, or their carbonates, and then dried up with sawdust.

The mixed salts of sulphate and muriate of the alkali, which crystallize out, are dissolved in water, and this solution, of the same strength as before, is employed as at first as the condensing medium in the columns or towers; and the above operations are repeated until the muriate of the alkali is converted into a corresponding sulphate.

When the liquor from the column falls below 5° Twaddell, the remains of the burnt pyrites are removed and replaced by fresh charges; and similarly when the muriate of the alkali is nearly decomposed into sulphate, the liquor is boiled down to obtain this salt, while it is replaced by a fresh solution of the muriate.

PROVISIONAL PROTECTION

HAS BEEN GRANTED FOR THE UNDERMENTIONED INVENTIONS.

2117.—William Johnston, metal merchant, and William Ross, brass-founder, both of Glasgow, N.B., for "*Improvements in taps or valves.*" Sept. 1, 1860.

2147.—Walter Robert Kinipple, C.E., of Limehouse, in the co. of Middlesex, for "*An improvement in water-closets, and in flushing tanks or apparatuses.*" Sept. 5, 1860.

NOTICE HAS BEEN GIVEN OF INTENTION TO PROCEED WITH THE UNDERMENTIONED INVENTIONS.

1173.—Thomas Nasmyth, of 31, Rue de l'Étoile, Brussels, gentleman, for "*Improvements in taps and valves.*" A communication. May 11, 1860.

1201.—Domingos Sant Agata, of Lisbon, in the Kingdom of Portugal, for "*An improved disinfectant.*" May 16, 1860.

1268.—Michael Henry, of 84, Fleet Street, in the City of London, patent agent, for "*An improved mode of suspending gas lights.*" A communication. May 22, 1860.

1287.—Robert Calvert Clapham, of Walker, in the co. of Northumberland, analytical chemist, and Richard Cail, of Gateshead, in the co. of Durham, chemical manufacturer, for "*Improved deodorizing agents.*" May 24, 1860.

1316.—The Rev. Henry Moule, of Fordington, in the co. of Dorset, clerk, and James Bannehr, of Exeter, agent, for "*Improvements in the nature and construction of closets and commodes for the reception and removal of excrementitious and other offensive matter, and in the manufacture of manure from thence.*" May 28, 1860.

1666.—William Kemble Hall, of 36, Cannon Street, City of London, engineer, for "*Improvements in gas regulators.*" A communication. July 11, 1860.

1852.—Alphonse Vital Dormet, C.E., of Lyons, for "*An improved registering water-meter.*" July 31, 1860.

2070.—Colin Mather, of Salford, in the co. of Lancaster, engineer, for "*Improvements in gas-singeing apparatus.*" Aug. 27, 1860.

Miscellaneous News.

CITY OF LONDON COURT OF SEWERS.

THE METROPOLIS GAS ACT, 1860.

The Commissioners of Sewers of the City met for the first time after the summer recess, on Tuesday, Sept. 11, in the Sewers Court Room, Guildhall. Mr. Deputy Christie, the chairman of the commissioners, presided.

Dr. Abraham rose, in pursuance of notice, to move the following resolution—"That it be referred to the General Purposes Committee to consider the bearings of the Metropolis Gas Act upon the interests of the ratepayers of London, and whether it is advisable to take any measures to protect those interests, and to report thereon to this commission. Dr. Abraham commenced by observing that, since the last meeting of the court, a law had been made which he thought would be prejudicial to the citizens, or rather the gas consumers of the City. The Act was entitled "An Act for the better regulating the supply of gas to the metropolis," but the clauses in this bill certainly did not carry out such a title. The preamble stated that the different metropolitan gas companies had agreed each to take a separate district and supply it with gas, with a view to economize capital, and avoid the unnecessary breaking up of the public streets. The City, under the state of things which preceded the passing of the Act, was especially favoured by its being supplied under the stimulus of a sharp competition; but, he contended, the effect of the passing of this extraordinary piece of legislation would be to do away with all competition, and to create and perpetuate a system of monopoly adverse to the public interests. At the present moment they obtained their gas from the Great Central Gas Consumers Company, and he was very glad to see the chairman of that company (Mr. Deputy Dakin) present, and he hoped that that company would co-operate with the citizens of London in the supply of gas, they having been taken in by this piece of legislation. Now, as to the quality of the gas. If any complaint should arise of the quality of the gas, they had their remedy by applying to the Secretary of State within a month, and he would appoint some one to ascertain whether the complaint was well founded or not. This was to be done at the expense of the citizens; whereas, under the former Act, this was done at the expense of the company; and then a certain number of hours notice must be given to the person who was to test the quality of the gas. But a complaint of three hours ago might not be a complaint now, and therefore this was, indeed, very little or no protection to the public. According to the new law, if a man wanted to introduce gas into his house, before the gas company would lay down the necessary service-pipes he was obliged to enter into an engagement to pay gas-rates for two years, at an amount equal to 20 per cent. on the outlay, and 10 per cent. with cost of the meter, and to give security for the payment. But before the law was passed, any gas consumer could go to the Great Central Gas Consumers Company and require them to lay on the service-pipes, and require them to supply meters, and they had only to pay for the gas, and not give any security for it. (Hear.) But this privilege was taken away from them. At present, as for some time past, the price of gas in the City had been 4s. per 1000 cubic feet, but the companies might bind together and raise it to 5s. 6d., and they were empowered, without any remedy by the consumer, to supply, if they chose, cannel gas instead of common gas, and to charge 7s. 6d. per 1000 feet for it. At present, the citizens had the advantage of competition, which, he contended, was one of the greatest checks against commercial cupidity and imposition, but henceforward that competition would practically cease. At present, the Great Central Company would not charge more thon 4s. per 1000 cubic feet, and if their profits were more than 10 per cent. the consumers got the benefit of it. The bill as originally drawn did not apply to the City at all, but the Select Committee of the House of Commons to whom it was referred altered it so as to embrace the City, but that alteration was not made until the citizens had been excluded from opposition to the bill. They were unable to petition against it, because it did not affect them. They were, therefore, powerless. They had no chance of success, no matter how reasonable and how well founded their objection might be. This he called a discreditable and disgraceful dodge. And their privileges, which they had enjoyed for ten years, were taken from them in this very curious fashion. It was due to the citizens that the probable effect of the Act should be the subject of deliberate inquiry on the part of the court through a committee, with a view, if possible, to release them from the false position in which they were placed. The question was one of such great importance that it ought to be brought before every ward in the City; for unless the Great Central Company remained true to them, they would be left at the mercy of other companies. He concluded by moving in the terms of his motion.

Mr. Deputy Dakin seconded the motion. He said that the gentleman who had just sat down had indulged in a very lengthy and eloquent speech, and had made use of expressions—such as "dodging," and the like—in reference to the promoters of the bill. He begged to remind the court that it was introduced, not at the instance of the gas companies, but by the agents of the different vestries and parishes of the metropolis, who thought they had well-grounded complaints against the gas companies of the metropolis, and, as originally shown, it included the three gas companies which served the City, as well as those which supplied the metropolis. The bill was referred to the Select Committee, of which Mr. Sotheron Estcourt was chairman, and after examining into the complaints for twenty-eight days, they laid down the principle that a regulated monopoly was the true way in which the service of gas, as of water, ought to be conducted, and they declared that the complaints were groundless, and that the gas companies did their duty to the public, and the gas companies were not called upon to answer the complaints so made by the promoters of the bill. He thought it only due to the gas companies of the metropolis that he should make this statement. His friend, Dr. Abraham, had said that when the bill was first introduced it did not include the City. But in this he begged to say he was mistaken, for the preamble contained the whole of the gas companies, including those in the City of London. As to the monopoly clause of the bill, as his friend termed it, he was wrong in saying that the gas companies had anything whatever to do with its introduction. It was expressly inserted by the Select Committee. If Dr. Abraham meant to say that a monopoly in the supply of gas was a great evil, then he could only say in answer to it, he did not give any opinion of his own; but the Select Committee, composed of some of the ablest men connected with the subject, and a committee best able to form a judgment, gave it as their opinion that the only way to obtain a true supply of gas was by putting it under a strictly regulated monopoly. Dr. Abraham had entirely ignored the obligations which the Act imposed on the gas companies. Did he know that it made obligatory upon them the necessity of adding 20 per cent. of illuminating power more than that which they now supplied? Did he know that the gas supplied must be equal to twelve sperm candles, and that in default they were subjected to a penalty of £50 for every neglect, and £10 a day for every day it fell short of that illuminating power? and, in addition to this, did he know that it limited their dividends to 10 per cent.? Did he know, again, that there was a most stringent regulation in regard to the purity of the gas supplied, and that, if the gas was not up to the specified purity, in the same way the companies were amenable to the law, and subject to severe penalties; and the general effect of the Act would be to do away with the unnecessary breaking up of the public streets, and to lessen the deleterious tendencies of gas leakage, which now poisoned the soil of all our thoroughfares? The committee of the House of Commons, composed of able men, dealt with the question in a comprehensive spirit, having regard to the public interests, and he did not think the Act in which their inquiries resulted was open to the sweeping criticism to which it had been subjected by Dr. Abraham. He therefore seconded the motion, in order that an investigation might take place by one of the committees of the court.

Mr. Young said he thought that if the question was to be referred to a committee, it ought to be referred in all its branches, so that they might bring up a report upon the whole subject.

Mr. De Jersey supported the motion. He denied that the bill recognized the system, and deserved the name of a regulated monopoly. The gas companies had all combined in this matter, and, there being nobody to represent the public in this matter, it had passed the Legislature. He pronounced the bill to be one of those frauds which were perpetrated in the House of Commons for want of knowing better.

Dr. Abraham replied, and the motion was put and carried unanimously.

Dr. Letheby, the Medical Officer of Health for the City, submitted his quarterly report of the illuminating power and chemical quality of the gas supplied to the City by the Great Central Gas Consumers Company. The gas had been tested in the usual manner, and the average of 246 experiments showed that the illuminating power had been equal to that of 12·06 sperm candles, or 13·78 wax, of 120 grains hourly consumption. This is about 15 per cent. above the requirements of the Act of Parliament. The illuminating power of the gas had been tolerably uniform during the quarter, for the weekly ranges were but from 13·20 to 15·94 wax candles. The chemical quality of the gas has also been good, for there has been a total absence of sulphuretted hydrogen, and but traces of ammonia.

THE GAS QUESTION IN BRISTOL.

On Saturday last, a meeting of the Town Council of Bristol, acting as a Local Board of Health, was held in the Council Chamber.

The Town-Clerk said that, as the Mayor would not be present, it was necessary, under the Act of Parliament, to elect an Alderman to preside.

Mr. HERAPATH: The oldest Alderman?

The TOWN-CLERK: No, sir, a Alderman. (Laughter.)

Mr. Alderman Robinson was then appointed to the chair.

The TOWN-CLERK read a report from the Local Board of Health Committee:—

Your committee beg also to report that since your last meeting they have received from the inspector of gas-meters, &c., a report showing the results of another testing of the quantities of gas consumed in those public lamps which had been previously tested and reported on by him, which report is as follows:—

"*Bristol*, 13*th September*, 1860.

"*To the Chairman and Committee of the Bristol Local Board of Health.*

"Gentlemen,—It has doubtless been noticed that during the past week a discussion has been carried on in the public journals relative to the testing of the quantity of gas supplied to your public lamps, and as the consideration of this subject belongs to you as a committee, I have deemed it my duty to investigate the facts of the case and place them before you. With this view I have carefully tested, for a third time, the following undermentioned lamps—

Street.	No. of Lamp.	Pressure in inches of Water.	Class of Burner.	Amount of Consumption in cubic feet per hour.
Bridewell Street.	553	1.3	No. 5 batswing.	5½ cock full on.
Ditto.	555	1.3	No. 5 batswing.	5½ cock full on.
College Green	677	1.5½	No. 5 batswing.	5½ cock full on.
Ditto	669	1.5	No. 5 batswing.	6 cock full on.
Top of Park Street.	761	1.8	No. 5 batswing.	5 cock ¾ on.
Ditto	745	1.6	No. 5 batswing.	4½ cock ¾ on.

"You will observe from the above that the gas is now supplied at 5 feet per hour per burner, which was not the case when I conducted my first experiments.

"Is it not, therefore, a matter of the gravest importance to the public that some supervision should be exercised over the quantity of a material the due supply of which has become almost a necessary element of life? I have thought it necessary that you should be furnished with a report on the present supply of gas to your public lamps, for the purpose of explaining, if required, to the gas company, the quantity of gas now supplied to the public lamps, as furnished by your inspector.—And have the honour to remain, Gentlemen, your obedient servant,

"BENJAMIN KITT."

Your committee further report that, in accordance with your resolution at your last meeting, the clerk requested the directors of the Bristol United Gaslight Company to supply gas to the public lamps in the city and county of Bristol at the lowest price charged for the time being to any private consumer, calculating the quantity consumed according to the size of burners, no meters being used, and substituting No. 4 for No. 5 burners, the gas company to light, extinguish, clean, paint, and repair, as at present, at present charges, unless the company will agree to contract for one year on the terms of their tender on the 14th June last. In reply to such request, a letter has been received from the secretary of the gas company, addressed to your board, in which he states that he was instructed to acquaint you that the directors are willing to supply gas to the public lamps, in the manner specified, at a price equal to the lowest price charged for the time being by the company to any private consumer, no meters being used to determine the quantity of gas consumed. That the Local Board of Health will of course understand that, consistent with this altered mode of competing the charge for the lamps, the gas used during the mean of one hour per diem occupied in the lighting and extinguishing the lamps, and which would be registered by the meters, must be added to the quantity used during the nightly average of ten hours, shown by the table which regulates the hours of burning; the average on which the future charge will be computed will, therefore, be eleven hours; there must also be added the charge of 16s. 6d. per lamp per annum, the sum hitherto paid out by the company for labour, painting, and repairs. The said letter further states that the directors, although maintaining the principles and figures upon which their tender of the 14th of June last was based, are desirous of avoiding the great complaints and dissatisfaction which will inevitably arise from the diminution of light consequent on the change of burners, and also the difficulty which must be experienced in obtaining and adjusting the new burners by the 29th instant. They have therefore determined to make the following proposal, as a matter of compromise, viz.—To contract with the Local Board of Health to supply the lamps in the city and county of Bristol with gas on the terms of their tender of the 14th of June last, for a period of two years from the 29th day of September next ensuing. Your committee having considered this letter, and looking at the difficulty of making fresh arrangements in so short a time as will intervene between this time and the 29th of September, recommend the acceptance of the tender for two years, on the terms of the gas company's tender of the 14th of June last, as a matter of public convenience. WILLIAM HERAPATH, Chairman.

Bristol, *September* 20, 1860.

Mr. Alderman ABBOTT moved the adoption of the report. He said he was not present at the last meeting, when the question of the new contract with the gas company was discussed, but he did attend the previous meeting, and was certainly in a very small minority. He had felt that the proposition suggested by the Board of Health Committee was one that would not lead to any practical result: but a discussion came on, and he was told shortly afterwards that many of the board concurred in his views. He could not help thinking it was highly creditable to the directors of the gas company that they have made the concession which they appeared to make, because the city would have been placed in a very awkward position indeed, if the views of the Board of Health had been insisted upon and carried out, as proposed at the last meeting. He was happy to see that at that meeting there was a considerable minority against that proposition of the committee, which he must say was a very clumsy one, which would have been rendered much more conspicuous if carried out, for it would have reduced the light about 20 per cent., or one-third less, the city being obliged to pay about the same money, if not more than they now have to pay. He was told the gas directors had increased the light considerably, and looking at the charge, it would have been something more than what the directors now offered to supply gas for. He could not help remembering that the gas directors were engaged in administering a very large property, involving the interests of a very large number of persons; and although their position might be considered a victorious one, it often happened that a victorious general made a bridge to retreat over. He thought that the directors, in suggesting the adoption of the tender for two years, had suggested a course which, in the end, would tend to satisfy and benefit all; and he was very happy indeed to congratulate the city on the termination of a contest, which, if fought out, would have done good to neither party. They were getting by the new contract a considerable diminution in the price of lamps, while a considerable time was before them for coming to a satisfactory arrangement of the question, if properly gone into, but an arrangement which would not be satisfactory if carried out in the spirit that appeared to animate some gentlemen of the committee towards the company. As to the alternative about requesting gentlemen to take shares in a new company, he could not help thinking it would be a very extravagant and costly investment indeed while anything like a reasonable course was proposed on the part of the gentlemen interested in the present gas company. It was a matter of very great delight that the council had an opportunity of accepting terms which he thought would be generally satisfactory; and he had no need to say a word to disturb the harmony of this final arrangement. (Hear, hear.) The citizens would be satisfied that they were dealing with a large company who had conceded the point at issue with great advantage to the public.

Mr. VISGER and Mr. R. P. KING rose simultaneously to address the board, but Mr. King resumed his seat and allowed Mr. Visger to second the motion. He (Mr. V.) congratulated them that a course had been suggested which would tend to calm down their differences, and that was a result all had desired. A couple of years would give ample time for that calming down, and they would be able to approach the question in a manner suitable to its importance. He was happy and rejoiced in an opportunity offering such an advantage.

Mr. R. P. KING said, while he agreed in some of the remarks that had been addressed to the board, he thought their thanks were due to the committee for what had been done. They had had to negotiate with a company who had the monopoly of supplying gas; and though it might be said that they had proposed a clumsy arrangement, he considered that the thanks of the meeting were still due to them.

Mr. WARREN was afraid he should say one word to disturb the harmony—viz., the committee, in accepting the contract for two years, had not at all altered their opinion as to the unfairness and excessive character of the charge in the tender of the gas company. They were fully satisfied that the price charged in Bristol for the public lights was much more than in any other city of the same size and population. Was it not monstrous that Bristol should pay £3000 a year more than Manchester for lighting, where the area was so much more extensive? In all the committee's reports they had proposed to have the contract for one year, and the gas company proposed to give it for two years. The committee held that it was not a matter of very great consequence taking the tender for two years, but they did not intend to relinquish the attempt to get the city put on a fair footing in this matter. The board had ordered an investigation of the gas company's accounts, and he trusted that inquiry would take place in a fair and proper manner, with the consent of the gas company, if they had not already acceded to it; for it must be to their advantage, and to the advantage of their shareholders, that everything should be made fair and open. If it was proved, when the investigation took place, that the gas company could not afford to make any further reduction, he was sure the committee would not be inclined to press the matter; but there was a very strong *primâ facie* case on the face of the statement of accounts that they could make the reduction the committee sought, and largely reduce their charge to the private consumer. There was one fact which had come to their knowledge while pursuing this subject, which was of some interest. In investigating the accounts of the Glasgow Suburban Gas Company, it appeared that the revenue of that company was just the same as that of the Bristol Company—about £52,000—and they paid a dividend of 10 per cent, while they also paid £18,000 a year more for coal than the Bristol Company. What, then, did the Bristol Company do with that £18,000? Why, the Bristol Company were receiving £17,000 more than they received in 1853, and yet they put down their profits at £653 less! These were facts which, he submitted, made a *primâ facie* case which, if they went into an investigation, would show that the company could afford to make the reductions asked for.

Mr. HERAPATH thought that Mr. Abbott must not take credit that the gas company were victorious. Some good had arisen from what had recently been taking place. Before certain experiments had been made, the gas-lights did not consume their proper amount of gas, supposing the experiment made by their inspector to be correct. This difference had been discovered—the lamps did not consume 4 feet, whereas now they burned 5 feet. Consequently, by some means or other, either through the improper management of the directors or the carelessness of the men, the city had been deprived of 20 per cent. of gas. But he would not find fault that as before they had only 4 feet they now had in some cases more than 5. It was fortunate, however, that the proposition of the Board of Health was not taken, for certainly this would have resulted—burning 4 feet of gas for 11 hours, there would have been 16,016 cubic feet, which, taken at 3s. 9d., the lowest price charged to consumers, would give the cost for gas £3. 0s. 2½d.; adding thereto 16s. 6d. for lighting and cleaning, made it £3 16s. 8½d. Thus they would have had to pay 1s. 8½d. per lamp for one year more than the company had offered to supply them for. It was useless making calculations comparing one town with another, for every town had its own peculiar local facilities for making gas. In one town, the coal might be as low in price as another, yet the coke might yield as much as the coal was bought for; in another place, the coke might not fetch much, the coal being very rich for gas making. As to Manchester, too, the consumers were many of them very large ones—something like the Bristol Cotton Mill, and but a small quanity of main was there required. However, taking on the one side the monopoly of supply, and on the other a helpless population, the only way he thought of getting through with the Bristol question was to have an investigation of the accounts. If a proper account could be obtained by the council, so that they might see what was really the profit and income of the gas company, whether it was properly expended, whether any was applied to capital, and if due economy were exercised in the works—if they found those points correct, the board would have no right to claim a reduction if their dividend were under 10 per cent. But if it turned out that their profit afforded them more than 10 per cent., then the price ought to be reduced for the public lamps and for the private consumer. They ought to go together; the public lamps ought not to be benefited at the expense of the private, nor the private at the expense of the public lights. These were the true principles on which the house should act. If they had the means of obtaining a proper statement of account, he thought that was the first matter to be attended to. There was another point he must say they were not agreed upon, and that was the quality of the gas supplied. Great complaints were made that meters ran round uncommonly quickly, especially at some periods. He had no doubt the quality of the gas had something to do with it—the gas being worse, the consumer was obliged to use more to get the same amount of light as heretofore. He would like to see a proper authentic report upon the quality of the gas. He did not believe it was equal to what the company ought to afford, but he knew it was beyond what their Act compelled them to furnish, because by a ruse in the House of Commons they managed to get the illuminating power for the public lamps reduced to that of ten candles. The company ought certainly to let them have gas equal to what was supplied in London and other large places. The quality of the gas, however, was a matter yet to be discovered, and he looked anxiously for the report of their gas inspector. It was a pity, he thought, to reopen the question that had lately agitated them; they would have two years before them for quiet working, and would by the present arrangement gain £600 per annum. But they would not have the opportunity of reducing the burners from five to four feet.

Mr. Alderman ABBOTT was about to offer an explanation, when

Mr. PERRY rose, and said he was exceedingly obliged to Mr. King for the very kind way in which he had mentioned the committee. Although Mr. Abbott had designated their doings as a clumsy arrangement, he (Mr. P.) thought that gentleman's remarks quite as clumsy as anything that had been advanced. He told them they were going to lose 33 per cent. of light by taking off one-fifth of it. How that was to be brought about he (Mr. P.) did not know, and he called it a "clumsy" remark. If the gas company would take the matter as a victory they might; but the committee said they had the victory, although they had given the company the chance. If they had made the proposition at a conference before, it would have been

acceded to. The committee asked the contract for one year, the company offered it for three; but had a gentleman near said, "Take it for two years," there was no doubt all the late difficulty would have been avoided. As to the quantity of gas supplied, it was not controlled by the directors and engineers, but by the lamp-lighters, who turned on the taps some three-quarters, and some what was thought to be about enough to permit 5 feet to be consumed. He thought those were not the proper persons to regulate such a matter. It was said they would be supplied with the same amount of light as before. He again thanked Mr. King for so kindly alluding to the committee.

Mr. Alderman ABBOTT was sure he spoke with very great deference about anything being clumsy, but all he could say was that he heartily rejoiced at the result arrived at. What he wished to say by way of explanation was, that Mr. Herapath, with his usual ingenuity, made the amount of gas supplied lower than it should be. Now, he (Mr. Abbott) never suggested that the company supplied the full quantity.

Mr. HERAPATH explained that he had stated if they took off 20 per cent. of burner, they would lose more than 20 per cent. of light.

Mr. FRY said the committee had pressed on their proposition because they considered it economical, while they considered the other unfair.

Mr. TOVEY would advert to one thing as being "clumsy," and that s the way in which the lighting of the public lamps was managed. On e Continent he found that instead of the tap being at the top of the lamp-post, it was placed at the base, and the lamplighter was able to light the lamp without running the risk of breaking his neck, though he performed his duty in the rapidest way, running along with a lantern at the end of a pole, and occupying about a tenth of the time a Bristol lamplighter would take. It would also cause a saving to the gas company. From his prominent position on the Crescent, he could see the lights in the city burning two hours after daylight in the morning, and they were generally lighted an hour before dark. He thought such an expenditure of gas need not be, if the Parisian plan of lamplighting were adopted, and he fancied it would prove an economical arrangement.

The report was then adopted, and the board broke up.

REPORT TO THE NEW RIVER COMPANY
ON THE
CORROSION OF IRON MAINS FROM THE EFFECTS OF GAS LEAKAGE, &c.

Gentlemen,—In compliance with your instructions, I have the honour to submit the following report on the causes and prevention of the premature decay to which so many of your iron mains are now subjected. That this decay is premature, and not of a nature to have been anticipated in the ordinary course, a few words will place beyond doubt; and that its prevention does not rest directly with you will, I am afraid, be equally so. I may premise that the conclusions I have to lay before you have not been arrived at hastily, but result from a series of observations and experimental investigations, continued at short intervals since you directed my attention to the subject.

Preliminary Observations.

In the first place, it is observed by your engineers that cast-iron piping laid in earth not subjected to more moisture than that due to absorption from rain-fall, has not undergone any appreciable decay since its introduction to the metropolis in 1812. This fact is arrived at by the unimpaired condition in which many of the original mains are found when removed from commonly clean earth, to make room for those of a larger diameter. There is no reasonable doubt, therefore, that the effective duration of cast-iron piping, laid in such earth, is not over-estimated at a century. This, I am glad to say, entirely accords with the opinion of Mr. Mylne, whose practical experience of iron mains extends since their introduction. It is also that of other engineers with whom I have consulted. I assume the normal duration of iron mains, therefore, at a century.* On the other hand, from the condition in which many are found that are taken up from the denser parts of the metropolis, it is evident that circumstances of an injurious character are in active operation, which prevent the serviceable duration of many of them beyond ten years.

It is now three years since my attention was called by your engineer to this striking disparity, his object being not so much to fix the cause, of which his experience rendered him satisfied, as that I might suggest some remedy. That the shorter period I have named is not exaggerated, has become abundantly evident by the numerous sections of mains which I have seen as they were removed from the ground in a complete state of decay, some of which, I was assured, had not been in use beyond periods ranging from seven to ten years. I may add, that the data of their duration are readily gathered from your office books, which show when mains are laid down in each street, and when renewed. It is to be remembered that no question of interior decay forms any part of this investigation,—the nature of the water supplied by the company affording to cast-iron its best possible protection; nor is there any complaint on this score.

The species of corrosion I was thus called to report on, did not appear to be in the nature of ordinary rust, but an indirect consequence of a continued escape from the joints of the gas-mains, as well as from decayed wrought-iron service-pipes, many of which are laid side by side with those of water. What renders this escape more important is, that it is scarcely adventitious, or arising from remediable faults of workmen. It is, on the contrary, a species of chronic leakage, inherent to the mechanism of the joints themselves and the nature of the material, as regards many of the service-pipes.†

As will be seen farther on, if variations of temperature alone are taken into account, it is not too much to pronounce it to be physically impossible to make perfectly tight joints by the system adopted by the metropolitan gas companies—that is to say, joints that shall be capable of sustaining themselves perfect for several months together.

Hence the earth of our greater thoroughfares, where the mains of several companies are often laid, has become saturated with gas. It will also be shown, that earth in this state exercises a corrosive action on cast and wrought-iron, of a far more destructive character than that arising from any ordinary circumstance: and, moreover, that no coating of varnish is capable of affording them protection. It is therefore obvious, that the remedy must proceed from the gas companies themselves.

Apart from your mains, it will be further shown, that the injury sustained by the public is of no less magnitude. This is so manifest, that I am much surprised the Legislature has not already interfered to cause the gas companies to adopt means to prevent the escape. I can only account for its long endurance by the public, from the prevalence of a belief that no more efficient mode of jointing is known, or practised elsewhere, and that this gaseous impregnation of the street earth—which every one knows, and complains of—is one of those inevitable evils we are bound to bear, as a species of compensation for the greater benefits derived from this mode of lighting.

Before going further, I may as well say that, personally, I entertain nothing in the shape of prejudice against gas, even for domestic use, though I am aware many do. Apart from its invaluable services in the laboratory, it lights most rooms of my house. Indeed, rather than be deprived of it, I believe I should be content to submit in quiet to the injurious effects I am about to point out. At least, were I not satisfied that they are susceptible of easy remedy, I should hardly advise the New River Company to be instrumental in merely pointing out a state of things for which there was none.

In describing the effects of gas leakage on your pipeage, it will be necessary to say a few words as to its indirect action on the earthly substances of the streets before it acts on iron. It would swell this report to an undesirable length to detail the experiments made in the course of the inquiry; I shall therefore only refer briefly to those which led to the more decided results.

Chemists have hitherto had little call on them to study the reactive effects produced by the escape of coal gas in common earth; it being looked on as an adventitious circumstance, which could never be permitted to degenerate into anything approaching to permanency. By common earth, I mean that in which peroxide of iron, sulphate of lime, clay, and organic matter are among the constituents, along with moisture. These are found, with more or less of sand and calcareous matter, in most of the street earth in and around the metropolis.

I have already stated that iron pipeage, laid in this earth, when not subjected to any other moisture than is absorbed from rain, continues so long unimpaired as to afford little or no ground of complaint on the score of duration. Moreover, from improved street paving and drainage, the chance of receiving more injurious moisture is rapidly diminishing.

On the other hand, the duration of iron pipes laid in earth which has become saturated with gas is so much shortened, that their frequent replacement entails an increasing and unexpected expenditure on the New River Company. At the same time, the limited duration of the metropolitan gas-pipes, especially the smaller ones of wrought-iron, must have easily forced itself on the attention of their proprietors, and have since prompted them to take advantage of the opportunities they have so frequently had to amend their revenues. In 1852, however, when the Legislature settled the water companies rates, no margin was allowed for any increased outlay which might possibly arise from this cause. It is true, the evil was even then occasionally complained of by the public, but it was hardly, if at all, recognized as a source of permanent injury to iron pipeage, and, therefore, did not enter into calculation. I certainly do not remember that anything was said on the subject, in the course of the very lengthened evidence given in that and the preceding year, though the introduction and use of iron mains were referred to at considerable length. In short, it was tacitly believed that, unless subjected to ill-regulated pressure, water-mains were practically indestructible; which, in the absence of abnormal corrosion, is not far from the truth. At present, however, when so many are found in a state of unlooked-for decay, side by side with gas mains, and seeing that it can be established that this is not so where gas is absent, it is natural to look in that direction for the cause, and also to point out the best remedy that presents itself.

Notwithstanding the strong nature of the evidence of gas escape, on my attention being directed to it, several lengthened experiments were undertaken, with the view of identifying and separating it from any other cause of corrosion that might be in operation. I confess that, although the effects were so obvious, still, looking at the tolerable state of purification in which the gas (carburetted hydrogen) is said to reach the mains, I thought it hardly capable of being explained on the ground of direct action. Certainly, were all the sulphur, the ammonia, and its cyanide present, which belong to the gas before it undergoes purification, then, indeed, I should have had less difficulty in understanding the effects of its escape. It would have been easy to see how the sulphur, in combination with the ammonia and moisture, acted directly on the iron to form the plumbago-like substance intow hich so many portions of the water-mains are converted. It is to be borne in mind, however, that the purification of gas is never so perfectly carried out as to render it thoroughly free from these bodies on entering the mains, more especially from sulphur in combination with carbon; though, I confess at the outset, I hardly expected so much as would appear from a recent report to which I am about to refer.

While there need be no doubt that gas may be deprived of the whole of its original sulphuretted hydrogen, it appears that none of the purifying media used in the metropolis entirely free it from sulphuret of carbon, or the whole of its ammonia.

We have a statement as to the quantity of these substances left in it, on entering into consumption, in a report, published a few weeks since, by the "City Sewers Commission." This document states, that the result of twenty-eight quarterly reports, each embodying a larger number of experiments, shows the gas in ordinary use "does not contain more than 20 grains of sulphur, in any form, in 100 cubic feet of gas, and that the proportion of ammonia does not exceed 5 grains per 100 cubic feet." Now, although the amount of these impurities is spoken of here mitigatedly, it is only because they were formerly greater; but when taken in connexion with the enormous amount of leakage which we know to be always going on, they will be found almost equal to the production of the effects of which there is so much reason to complain.* Moreover, we must take into con-

* Apart from the date of the introduction of water-mains, cast iron, in a very good state of preservation, has been taken from metropolitan earth, in which it is known to have lain nearly a century.

† I believe many of the service-pipes are made of wrought-iron, which will sufficiently account for the rapidity of their decay.

* From a return made in 1857 to the government referees on the metropolitan drainage, by Mr. Lowe of the Chartered Gas Company, the annual amount of coal gas made in the metropolis is 7,728,000,000 cubic feet; which, looking at the natural ratio of increase in three years, would now amount, in round numbers, to 8,000,000,000 cubic feet. I have been informed, however, that this is an over-estimate. I shall take it therefore at 7,000,000,000 cubic feet. Though I am satisfied that the amount of loss from all causes, including leakage, condensation, dishonesty, and bad debts—I allow nothing for defective meterage, as I have reason to believe that does not run, as a rule, against the companies—all these will amount to a loss of nearer 25 than 20 per cent., though in some instances it exceeds 30 per cent. As, however, an average of 20 per cent. total loss is acknowledged, let it be taken at that, when we shall see the enormous amount of gas that escapes annually into our street earth. To come at it fairly, let me take Liverpool as an example. In that town, where the jointing is, as a rule, perfect, only 11 per cent. of the whole manufacture is accounted for. I need hardly say that company is, in other respects, subject to every species of loss encountered by the metropolitan companies, and, from the superior quality of the Liverpool gas, a much larger loss is sustained from condensation; besides, the meterage is more sharply inspected by a special officer on the part of the public. I shall therefere be within the mark, when I set down the excess of loss sustained in the metropolis, as compared with Liverpool, to leakage,

sideration that they are, to a considerable extent, cumulative, while the cause has been in operation for more than a quarter of a century. Nevertheless, as neither sulphuret of carbon, ammonia, nor coal gas have, alone, any direct action on iron at a common temperature, it became evident to me that some otherwise inert element was brought into activity by their agency.

A preliminary examination was therefore made of a specimen of the blackened earth, the odour and appearance of which is now so familiar to the in-dwellers of the metropolis. It was taken near the leaky joint of a gas-main. Its strong odour left no doubt it was derived from illuminating gas. On applying tests, it gave a strong alkaline reaction. In addition to the earthy constituents I have enumerated, it contained a substance composed of iron, sulphur, and carbon, and to which its black appearance was evidently due. This compound, however, was separable from the rest of the earth by washing with water. On boiling it in dilute hydrochloric acid, sulphuretted hydrogen was given off. Another portion, boiled in caustic soda, also showed the presence of sulphur in combination with the alkali. It now appeared less difficult to account for the corrosion complained of.

Another portion of earth that had been taken a few yards from the same spot, under the flagging and at about the same depth, but at a considerable distance from any gas-pipe, presented no blackened appearance, or emitted any odour, other than that appertaining to the reddish sand and gravel ordinarily met with. It was evident, therefore, that the effects of gas had not spread thus far. On boiling portions of this specimen with dilute acid, and then with an alkali, as in the former case, no traces of *free* sulphur were detected, nor did it give any previous alkaline reaction with test-paper. It is true that oxide of iron, sulphur, and carbon were contained in it, but *not in the same* state of combination in which they were found in that taken nearer the gas-main—which is important. The oxide of iron existed, in the inodorous specimen, as inactive reddish ochre in mixture with calcareous earth. The only sulphur present existed in the form of sulphuric acid in combination with lime; forming, in fact, ordinary gypseous earth, which, as far as iron is concerned, is inert and without odour, and colourless. A little carbonaceous matter was also found in the form of brown humus, being the well-known substance accruing from decayed vegetation, but which has no action on iron.

Similar experiments, made with portions of earth taken from other streets, gave, as nearly as possible, similar results.

In short, the relatively harmless specimens gave the same elementary constituents as the others, but without their odour or blackness. It appeared, therefore, that the presence of gas was only wanting to produce the blackness, odour, and injurious action complained of. Meanwhile, it was not sufficiently clear why an escape of gas—which, in a state of ordinary purity, does not in itself corrode iron—should be the cause of corrosion, when this metal happens to be in earth which by itself does not act corrosively. In a word, each body when apart is almost equally without action on iron. The effects in question were, therefore, only to be accounted for on the highly probable supposition that gas, on its escape, gives rise to a decomposition of the gypseous constituent of the earth. From the numerous and scarcely yet explained decompositions that arise from hydrocarbons, this was far from being improbable. Therefore, supposing the gas itself to be free from sulphur on its leaving the manufactory, and taking into account the free sulphur I found in the blackened earth, it seemed obvious that gas, in connexion with the other bodies present, promoted the decomposition of the gypsum—it being the only body belonging to the earth which contained sulphur. That the liberated sulphur would afterwards enter into combination with the iron, from the strong affinity these bodies have for each other, and thus give rise to the active corrosion of which we complain, there would thus be little doubt. This view of the case was borne out by the subsequent experiments to which I am about to refer.

I may remark here, that it does not follow that gas mains are necessarily more liable to corrosion from this cause than those lying side by side with them, since the chemical reaction of the gas on the earth scarcely commences at the moment of its escape.* On the contrary, it must have time to diffuse and condense itself throughout the moisture abounding in the earth. As regards moisture, it is not too much to say, that any amount of gas escape into perfectly dry earth would be harmless, as far as the metal of the mains is concerned, though the odour would become so manifest that a remedy would not long be wanting. As it is, the moist earth absorbs the escaped gas to a certain extent; its presence, therefore becomes partially masked. The result, however, is to convert the moisture in the earth into an acrid alkaline fluid, which I subsequently found to be a chief promoter of this species of corrosion.

Experiments and their Results.

Though the reactive effects of gas on gypseous earth might have been predicable from several known analogies, it was desirable, before reporting to you, that it should be tested by experiment.† The question, however, was not one that could be solved by mere analysis. To place it beyond doubt, it was necessary to make experiments more of a synthetical character; that is to say, such as should, as nearly as possible, imitate the circumstances the mains were subjected to in the earth, and in which time formed a large ingredient. The period occupied in the inquiry I trust, therefore, will not appear too protracted; especially on considering that, in practice, the evil manifests itself only after years of slow, but at first hardly perceptible action, and which, in its infancy, might have been attributable to other, though cognate causes.

A lengthened series of experiments was entered on accordingly, the nature of which I shall indicate before stating the results.

A number of pieces of turned cast iron were procured, having their surfaces brightened in the lathe. The superficies and weight of each were made as nearly as possible alike, though the fractional differences were separately noted previous to the experiments. Several specimens of blackened earth were then procured from streets broken up for repairs. I may remark that the worst were obtained in narrow thoroughfares, where the water mains, in a highly corroded state, lay at little distance from those of gas. The characteristic odour which was emitted from the specimens after collection, left no doubt of their being surcharged with gas. Other specimens, in a less contaminated state, were also procured, which, though not so black, emitted gas odour equally strong. Specimens were likewise procured from streets where the earth appeared to have suffered less change, and which were not accompanied by any very perceptible odour of gas. These latter may, therefore, represent the ordinary reddish sand and gravel earth in its natural state—in fact, as it exists in newly formed wide streets.

Immediately after collection, portions of all the specimens were respectively put into porous earthen garden pots, with one of the pieces of turned cast iron near the bottom of each. The pots were numbered, and separately labelled (the labels were enclosed in glass phials), and then put into the ground in a back garden, and covered with about 10 inches of common garden mould. It was determined to let the whole remain so for the subsequent twelve months. At the termination of this period, one pot from each series was removed, and its piece of iron was taken out and carefully washed and weighed.

Though the results of these experiments, as well as those of others that were allowed to proceed for another year, fully established the greatly increased rate at which corrosion takes place in gas earth, yet large allowance had to be made for the absence of several conditions which can only be maintained in actual practice. For example, during their continuance, the gaseous odour of the specimens of collected earth was necessarily exhausting itself. In practice, on the contrary, the leakage being continuous, the corrosive element is as continuously increasing. Again, the weight of the pieces of iron that had been left in the earth free from gas odour, had in some degree increased. As their surface was found covered with a tenacious coating of ordinary red rust, the absorption of oxygen readily accounted for this circumstance. Subsequent examinations of the pieces left in similar earth during the following year, went far to show that an equally additional period does not equally add to the amount of corrosion. In short, it became established, in the course of these experiments, that the first coating of natural rust, *if not removed*, acts protectively to the metal underneath; and that, on the termination of a few years, a close coating forms, which serves as a very good practical preventive to its increase. On no other principle can we account for the almost perfect state of preservation in which mains are found, which have lain so many years in moist street earth in its natural state. I have little doubt that four or five years are sufficient to form a protective coating of this character on cast iron; while the action itself becomes gradually less, year by year. Wrought iron, however, if left in earth under the same circumstances, perishes in a comparatively short time.

I now come to the pieces of iron that had been put in the blacker gas earth. On removal, their surfaces had become blackish grey, presenting a very different appearance from those which were covered with ordinary rust. The former, on being washed, were found to be several grains lighter than at first. It was also found that their corroded particles *did not adhere* as in the case of ordinary rust. In this circumstance we shall presently see the cause of the great difference of the results in the two cases, and also the hopelessness of finding any resisting varnish. Above all, the blackened surface of each piece was slighly penetrable with the blade of a knife, and, consequently, by scraping, their weight might have been reduced still further.

These, and the results of several other experiments of a similar character which were allowed to continue during the following year, sufficiently established the nature of the important difference between the corrosive action occasioned by the gas earth, and that of earth in its natural state.

As the ultimate object of the inquiry was to determine whether any varnish afforded protection to iron from such extreme decay, a series of experiments, with special reference to this object, was put into process simultaneously with those just referred to.

I may previously state, that protection by means of coatings of zinc or earthenware enamel, though often suggested, is for a variety of practical reasons, altogether out of the question for water or gas mains, even irrespective of the great expense.

A number of specimens of varnishes were procured, and on coating several pieces of brightened cast-iron with each (according to the instructions of their respective makers, when thoroughly dry, they were enclosed in pots of blackened gas earth, and placed in the ground, as in the preceding experiments.

In these, as in the former, allowance had to be made for the necessary absence of many of the conditions of actual practice.

Though some of the pieces of iron were removed at the termination of six months, the others were kept in the earth twelve and eighteen months. As the results are given further on, I need only state that I found no varnish capable of resisting the solvent action of the alkaline moisture of the gas earth. The experiments were made with the best of those varnishes and compositions, so often brought under notice as affording protection to the hulls of iron ships. Though none afford perfect protection to wrought iron in sea water, yet some of them are preferable to others. Nevertheless, on ascertaining the alkaline nature of the moistened gas earth, I had little hope that varnish of any description would be found to afford protection in our case. In short, no varnish known is capable of resisting alkaline moisture for even a relatively short period of years. Most, if not all, the substances entering into the composition of these mixtures are necessarily solvent in alkali. Varnishes that resist a dilute acid give way when continuously subjected to a weaker alkali. However, several other experiments, both as to corrosion and varnishes, were made in the course of the inquiry, but which with the following exception, need not be detailed. As its results go to show that coal gas promotes the decomposition of the gypseous matter found in the earth, it is of sufficient importance to be described briefly. I had a box or close chamber made of sheet lead. It formed a hollow cube of about eight inches. Into it was put a mixture of hydrous gypsum, peroxide of iron, and reddish clay, each being free from carbonate of lime. This mixture was slightly moistened with water, in which were 20 grains of earthy salts. The interior of the leaden chamber was fitted with perforated shelves, on which was put the earthy mixture, along with some pieces of clean cast iron. I need scarcely say that no free sulphur existed in any of these matters previous to the experiment. In the bottom of the box was an aperture communicating by means of tubing with a gas-pipe; while the top contained an aperture connected with an argand burner. When the top of this chamber was fitted gas-tight, the burner was lighted. By this arrangement it will be seen that all the gas consumed at the burner passed through the box, and necessarily came into contact with its contents.

The burner was kept lighted four or five hours, most nights, for nearly seven months, at the termination of which the box was opened, when this reddish earthy mixture had become black. The pieces of cast iron were also covered with a black substance, which, on being scraped off and tested, was found to contain sulphur. On farther examination, it was found to

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there being no other way to account for the difference in the two cases. We shall therefore have 9 per cent. of the whole metropolitan yield, or, in round numbers, 630,000,000 cubic feet of gas absorbed annually into the street earth. And, when we take further into account that, according to the report cited above, each foot of this enormous quantity contains something like one-fifth of a grain of sulphuret of carbon, and one-twentieth of a grain of ammonia, we shall then only be surprised that the effects, bad as they are, are not more sensibly felt.

* Besides, gas-mains being never subjected to anything like the pressure necessarily applied to those of water, may continue in use half converted to plumbago without the fact being discovered.

† Berthier has long ago shown that sulphuretted hydrogen is evolved on heating gypsum and carbon together. The presence of oxide of iron and moisture greatly facilitate the decomposition at a low temperature. Even the refuse of starch manufacture, when absorbed into gypseous earth, causes its decomposition, and is attended with a sulphurous effluvia.

consist of a sulphurous *magnetic oxide*. The blackened earthy matter also contained free sulphur, and manifested an unequivocal alkaline reaction. I had almost forgotten to mention that atmospheric air was admitted to the contents of the box during the day. Taking the gas, as supplied, to be not unusually impure, the quantity of sulphur thus found was not to be accounted for on any other principle than that the gypseous matter had suffered decomposition, which I have no reason to doubt. Indeed, it was confirmed by the fact, that the alkali present was not so much due to ammonia as to lime in combination with sulphur, as was shown by the subsequent finding of hyposulphite of lime.

The results of this experiment, taken in connexion with others that were previously made, left no doubt on my mind that the escape of gas into the street earth gives rise to decomposition of its gypseous constituent.

It was now, therefore, not difficult to account for the greatly-increased rate of corrosion of the iron mains, nor for the increasing offensiveness of the street earth.

Injuries sustained by the Company and the Public.

Though the evils arising out of gas leakage directly affect the company, there are others which scarcely less concern the public. On the occurrence of fire, for example, water-mains, of no great age but partially weakened by portions of them being converted into plumbago, are often ruptured by the pressure to which they are subjected,—bearing in mind that the resistance of a pipe never exceeds that of its weakest part, though the rest may retain its original strength. Though there is no variation of pressure at the source, yet, as fires generally occur at night, it is in effect greater then than during the day. I need hardly remark that the effect of a rupture, under such circumstances, occasions a partial stoppage of water when the most needed; and it is generally on such occasions that ruptures take place. To the cost of the pipes themselves is to be added that of breaking up the streets to replace them, which involves, to the public, a partial interruption of traffic. Besides, a want of water at such a time, when results alone are looked at, and little inquiry made as to their cause, tends to injure the company with the public.

I may mention another general evil, of considerable magnitude, much of which has its origin in gas escape. This consists in the action of gaseous sulphur on silver, to say nothing of a similar action on other metals. Though the fact is perhaps not generally considered, silver is as little acted on by atmospherical oxygen, even when moist, as gold or platinum. That is to say, it is practically as little susceptible of corrosion as either of those precious metals; and, were it not for the adventitious presence of sulphur in a town atmosphere, the whiteness and brilliancy of silver would maintain itself unimpaired. Had sulphur been, ever so slightly, a constituent of the atmosphere, silver would hardly have ranked among precious metals,—sulphur being the only substance, ordinarily met with, which has any power of acting on it. Whenever, therefore, this metal becomes tarnished, sulphur is assuredly the agent—the tarnish being neither more nor less than a coating of sulphuret of silver, which *must be removed* before it regains its natural whiteness and brilliancy.

Speaking practically, the value of silver—in the shape of plate—is less in the metropolitan atmosphere than in others where sulphur does not exist so abundantly. This will be evident, on considering that every time plate is cleaned, the coating of tarnish which has to be removed, consists of 108 parts of silver to only 16 of sulphur, to say nothing of the extra silver removed in the operation. Moreover, if the vast increase of silver surface since the introduction of electro-plate is taken into account, and that from the necessary purity of electro-silver, it combines more readily with sulphur (*i. e.* is easier tarnished) than ordinary silver, some idea may be formed of the vast annual waste of this metal in the metropolis alone. Many who have removed to London, from towns where gas is used quite as extensively, remark how much readier plate tarnishes here, though they have some difficulty in assigning the reason. Nor is this effect confined to houses where gas is used.

Not only have I experienced this, but am occasionally called on to account for it to others, who believe they are residing in a less contaminated atmosphere than the one they have left. And from the absence of cesspools, the superior width of the streets, and the smaller quantity of fuel consumed per head in the metropolis, one would naturally suppose that less atmospherical sulphur existed here than in other large towns; and, which no doubt, would be so, were it not for this chronic escape of gas into the street earth. Though I am far from intending to say that plate is not tarnished by sulphur derived from other sources, yet, I have no doubt, gas escape is the principal one.*

Other circumstances have been pointed out to me by Mr. Mylne, showing that the injury from gas escape is not confined to the exterior of water-mains, but that the quality of their contents is often affected. When, for example, the supply is shut off, they are liable to become only partially full, from the draught on them at the other end. Under these circumstances, the escaped gas penetrates their joints, and thus mingles with the water. Hence complaints of its nauseous quality are not unfrequently made, which, on examination, are found to have their origin in this circumstance.

Accidents have been occasioned from the same cause. On drawing water in the presence of a lighted candle, partial explosions are known to occur, by the ignition of gas on opening the water tap. To show why this happens, it may be necessary to explain that the joints used for water-mains are, in all respects, similar to those used for gas. Water engineers, however, profess to do no more than to construct joints which shall be capable of retaining the fluid with which they have peculiarly to deal; but, as will be shown, the same joints are incapable of sustained retention of gas. That which thoroughly confines water is far from being equally efficient for gas. A cracked receiver, for example, will hold water tightly enough, though it will allow gas to escape freely. In a word, the tenuity of the two fluids is widely different; and hence the necessity for a different joint in each case, though unfortunately, in the metropolis, one has hitherto been made to answer for both. It will be only necessary to describe the nature of this well-known joint, to show its peculiar applicability to water, whilst as regards gas, its essential unfitness will not be less evident.

Nature of the Water and Gas Joints in present use.

Originally, each main is cast with a widened socket at one of its ends, which is intended to receive the small end of another. When this small end is placed concentrically within its socket, it is far from fitting, in the ordinary sense of the term. On the contrary, space is left, in some mains, equal to half an inch or more, all round, which is filled up—first with hemp, and then with a plugging of lead. Now, the primary efficiency of this joint depends on the due performance of the mechanical operation of tightening each of these materials with the hammer, care being taken that the small end of the pipe shall maintain its concentric position as regards the socket. To effect this, in the first instance, the hemp is driven in by a process not unlike the caulking the seams of a ship. After this, a hollow fence of clay is adroitly manipulated round the outer lip of the iron socket, by means of which molten lead is conveyed into the vacant space which remains next to the hemp. On removing the clay, the lead in its turn is hammered tight, when the joint is considered finished; and so other joints are made by the same process, at intervals not exceeding 8, 10, or 12 feet—for miles.*

As I have just said, this species of joint is found to be sufficient for water, though it is far from being equally so for gas. Apart from the difference in the tenuity of the two fluids, the hemp, which constitutes the one part, is kept permanently tight in the joint of the water-main, by reason of moisture absorbed from its contents. In short, by being constantly moist, it is permanently swollen into the necessary degree of tightness; and, consequently, there exists a perpetual guarantee for its closeness, as regards water. Even should the lead become partially loosened, by the contraction and expansion consequent on change of temperature, still the moisture practically maintains the hemp in comparative tightness

Looking, on the other hand, at the contents of gas-mains, we shall see that, from the necessary absence of moisture, even were the tenuity of the fluids alike, no similar guarantee exists to insure the tightness of the hempen part of their joints, apart from the physical change to which the metals are subject.

Were anything wanting to prove the absolute inadequacy of these joints, the circumstance just named, in which we see the escaped gas permeating the joints of the water-mains, independently of the moisture of their hempen plugging, would be sufficient. Were, therefore, the gas companies to be able to retain the hempen portion of this joint in a state of permanent moisture, it would still be inefficient.

Leaden joints have another inherent objection for gas, which, but for their hempen part and the lesser tenuity of the fluid, would apply to their use for water.

Most observe that, on railways, the ends of the rails are never placed so closely as to touch each other. A trifling space, of about an eighth of an inch, is left between each, though, if laid in very warm weather, the space need not be so much. The longitudinal expansion and contraction incident to iron by change of temperature render this course necessary. In long lengths of iron, the change arising from extremes of temperature is considerably above what casual observers would believe, though necessarily recognized by engineers. For example, in warm weather the iron tubes of the Britannia Bridge measure several inches in excess of what they do in extreme winter; though ample space is left to meet the contingency, but which is scarcely practicable with gas or water-mains. It may be said of iron, above most other metals, that its molecules, from this cause, are never practically at rest. Hence arises the comparative insufficiency of varnishes to prevent corrosion of the metal beneath.

Of course, iron pipeage for gas or water, though some two or three feet beneath the surface, is subject to the same universal law; but its effects in relation to gas are felt more seriously than they are in relation to water. I have referred to longitudinal expansion only; but that arising laterally has also to be taken into account. It is evident that, however tightly lead may be driven into a joint originally, it subsequently becomes liable to continued disturbance from the operation of this law; remembering that there is no chemical adhesion between the iron and the lead, as in soldering—the joint being altogether mechanical.

Let me now, by way of example, take the joint of a gas-main that has been laid during warm weather, when its diameter and length are at their maximum. As soon as the coldest weather sets in, the size of this main, including its joint, will have reached its minimum. But in its progress from the one extreme to the other, it is evident that the joint must undergo disturbance, even though the lead and iron should expand and contract in an equal ratio. Unfortunately, this is far from being so, for the differential rate of expansion between cast-iron and lead is as 9 to 3½. In other words, the temperature necessary to increase a given length of cast-iron 9 inches, will increase a similar length of lead only 3½ inches.

It will now be obvious that a chief defect of the lead and iron joint, for gas-mains, arises from this important physical difference in the nature of the two metals. Notwithstanding the disturbance to which this joint is subjected by change of temperature, it is clear that if the metals composing it contracted and expanded in equal ratio, less injury would arise in practice. We see, however, that the lead and iron are each contracted to a minimum in winter; but as the contractile power of the lead is not equal to that of iron, it is obvious the latter, in contracting, will press the softer metal into a less diameter than it would have assumed naturally. On the return of warm weather, when the iron portion of the joint becomes expanded to its original diameter, that *originally belonging to the lead is never recovered.* Consequently space is left, between the iron and the lead, sufficiently large to allow of the constant escape of which we complain. Nor will it be urged, by those acquainted with the nature of gas, that leakage from so apparently trifling a cause can produce little or no effect in practice.

Though in relation to ordinary ideas of space, openings in themselves so minute, may appear inappreciable in practice, yet, if taken in connexion with carburetted hydrogen, they are very far from being so. Chemists know that apertures sufficient to exclude air and water will not exclude this gas. Even were it possible to keep the hempen plugging of this joint swollen by moisture, the difference in the physical properties of the two metals would still render it practically insufficient. In short, while altogether unfitted for the retention of gas, it is found to answer tolerably well for water. A few words will explain another equally important difference. Water-mains are seldom or never affected by extreme changes of temperature, because that of their contents seldom varies more than 10° or 12° of Fahrenheit throughout the year. It is true the contents of branch pipes are occasionally frozen, but those of the street-mains rarely: the water passing through them in winter being relatively warm, while in summer it is relatively cool. Consequently, the joints of water-mains are not so liable to be loosened by contraction or expansion as those of gas; and what little the former is liable to, is amply compensated by the permanent moistness

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* To afford some idea of the numerous sources liable to leakage in a given space, I may mention—on the authority of the Report on Metropolitan Drainage—that in 16 yards of frontage in Cockspur Street, there are not less than 80 gas joints; double and treble sets of mains, belonging to three different companies, being there laid side by side with those of water. Nor is this an unfrequent case. A plurality of companies, even in this respect, is not always attended with gain to the public.

* I believe it will not be an over-estimation to say, that there are more than four thousand miles of gas and water-mains in the streets of the metropolis. The large quantity of iron annually disintegrated therefrom, in the shape of oxide, may be inferred.

of their hempen plugging. Perhaps the best practical proof of their efficiency for water is, that in the course of the half-century that has nearly elapsed since their introduction, no great fault has been found with them.

Proposed Mode of Jointing to Prevent Leakage.

I have already said that, were there no better mode of constructing gas-joints, it might hardly have come within the line of my present duty to have pointed out the injury arising to the public from those in use. Fortunately, there is a better; nor is it one to give rise to objection on the score of its being untried, and therefore subject to possible failure. On the contrary, it is in successful operation in some of the largest towns in the kingdom, and was adopted by them, several years ago, to remedy the evils complained of here. Were I not cognizant of the relative state of backwardness of much of the mechanism of gas distribution in the metropolis, improbable as it may appear, I should certainly have concluded *à priori* that some insurmountable drawback existed to prevent its introduction that does not exist elsewhere.

In lieu of the lead and hempen joints, just described, Liverpool, Manchester, Leeds, and several other towns, have adopted what are technically termed "bored and turned" joints, which a few words will serve to describe.

The mains for this joint are cast with their diameter a little larger at one end the other. Before leaving the foundry, a few inches of the interior of their larger ends are subjected to a process of boring and grinding, which is, in effect, like preparing the neck of a bottle to receive its stopper. The exterior of the smaller end is then turned and fitted into the interior of one that has been previously bored. Thus, the small end may be looked on as a stopper, made, without difficulty, to fit into the neck of its fellow. On the termination of this operation, each main is numbered, so that the end of one may be fitted, without mistake, into the other. Not the least recommendation of mains prepared on this principle, is the rapidity with which they are laid down, especially where crowded thoroughfares are considered. I have witnessed small mains, on this principle, laid with more rapidity than the street could be broken up, or the earth filled in behind them; sets of workmen having these respective duties assigned them. This joint, where adopted, has reduced gas leakage to its practical minimum. Of course, in laying, the ends are coated with an unctuous cement.

Apart from my own observation, I have it on the authority of gas and water engineers of several towns, and of the inspectors of mains, that where this system of jointing has superseded the other, the street earth that was formerly contaminated has resumed its freedom from gas odour. The water engineer of Liverpool, where the improved system has been longest in use, assures me that his mains, which lay side by side with those of gas, are in no way affected, and that the earth is odourless.

In Liverpool, the loss accruing from leakage and all other causes is reduced to less than 11 per cent., much of which, the engineer, Mr. King, informs me is due to condensation; the gas supplied to this town being so much richer in carbon than that of the metropolis, it is, therefore, more liable to undergo such a change. The amount of loss is estimated by the knowledge that the company manufactures more gas by nearly 11 per cent. than, according to its books, is paid for. Estimated by the same standard, I have reason to believe the metropolitan companies average a loss of 25 per cent. of their whole manufacture, though I shall set it down at 20; a great proportion of which, we have too much reason to know, is suffered to escape into the earth of the thoroughfares.*

I am prepared, at the outset, for much opposition, on the part of the metropolitan gas authorities, to this mode of jointing. First, it is more than probable we shall hear of its having been tried "several years since," and that it was found "not to answer." Moreover, most will be aware of its use to "some extent" in several "places in the country," where it may "possibly answer," but that it is altogether inapplicable to "town," where street mains are so liable to be shaken by the "immense traffic" going on above them. While confessing my inability to see the force of a distinction, so often drawn in the metropolis, as to its street traffic and that of the larger manufacturing or commercial towns, I can only reply by pointing to the fact, that in the large towns where these joints do exist, leakage is reduced to its minimum, as proved by the street earth being comparatively without the odour of gas.

Surely in the crowded thoroughfares of Liverpool and Manchester, where mains with joints of this character have been long and successfully in use, there are streets in each quite as liable to be shaken as any of the metropolis, if weight as well as extent of traffic be taken into account. Our most crowded thoroughfares are generally so with relatively light loads and passenger vehicles.

Nor shall I consider it a reply to be told of some particular street in the metropolis, where mains with bored joints are, or were, experimentally laid down, and that the leakage continued as great as ever. To such a line of argument I should have to rejoin, that the inspector, under whose charge they were laid, had neglected to make a previous examination as to the workmanship of the joints; because, if they are prepared properly, and reasonable care exercised in laying, experience has sufficiently proved that they are comparatively free from leakage. On the other hand, if these joints are imperfectly bored or turned, and carelessly laid subsequently, they are, of course, as much subject to leakage as those I recommend to be discarded. At the same time, I should hardly think of employing workmen to lay down the new mains, in the first instance, whose experience had been limited to the old.†

Though the first cost of the improved system of jointing slightly exceeds that of the present less perfect mode, yet—to say nothing of the public benefit that will arise—the saving of leakage, and the infrequency of repairs, will soon render its adoption largely economical to the companies themselves.

With regard to the New River Company, I am satisfied that had this system of jointing been adopted for gas at the commencement, the duration of its mains would not now have become any subject of complaint. At the same time, were the improved system to become, henceforth, general throughout the metropolis, several years will have to elapse before the street earth regains its former condition.

Effects of the Sulphurous Oxide of Iron when carried into the Thames.

I have now to draw attention to by far the most important public effect that has yet arisen out of this abnormal condition of the street earth; though, let me premise that I do so here, only in the hope that its exposition may lead to the adoption of the remedy we seek.

For the last few years, public attention in and out of Parliament has been painfully directed to an effluvium from that portion of the Thames situated within the metropolis, while each succeeding summer seems only to increase the evil. During the session before last, a committee of the House of Commons was specially directed to the subject. On this occasion, we had lengthened evidence from several able experimentalists, along with the conflicting notions of rival though eminent engineers; and, consequently, no very definite conclusions were arrived at.

On its face, however, the cause of the evil seemed obvious enough, without being obliged to travel far. What so natural as to see it in the influx of sewerage water, continually flowing in from a population so vast? Plain as this appeared at first sight, yet in all the recent inquiries, for there were several, the conclusions were conflicting, though all seemed plain enough before examination. This chiefly, if not entirely, arose from the *peculiarity of the odour*, and the fact that *the water itself affords so few traces* of impurity. In a word, most concur in pronouncing the odour to be unlike anything smelled before; while the water, from which it appears to emanate, is relatively pure. This smell appears to partake of phosphuretted more than of sulphuretted hydrogen; while the odour emitted by other rivers, apparantly subject to similar contamination, and where the diluting water is far from being so great as in the Thames, is not nearly so offensive But, apart from this peculiarity, the odour is not manifested elsewhere as with us. There, the offensive emission is not confined to the high temperature of the two summer months of June and July, as it is here, but is found pretty constantly throughout the year.

Moreover, in other places, the odour is always that of sulphuretted hydrogen, and is seldom manifested much beyond the mouth of the sewer from which it emanates; less than a hundred yards of flow in the diluting stream being sufficient to destroy all traces of this gas. In proof of which, though ordinary acetate of lead test-paper detects it in sewer water alone, it fails to do so after entering even a small stream. Indeed, I know of no gas that is so rapidly oxidized, in air or water, as sulphuretted hydrogen; consequently, none so soon becomes inoffensive and harmless. It has frequently been my duty to make examinations for this gas in river water in connexion with the supply of other towns, besides closely observing the Thames in the course of the last ten years. Its case I find to be entirely anomalous, when compared with the operation of very similar causes in other rivers. The evidence I intend to adduce, however, will not be made to rest on my experiments alone. Indeed, under the circumstances, I prefer to leave my own out of view, and rely on the results of observers who had no special line of argument to support, especially as they happen to rank among the ablest chemists of the day.

In the very complete report, made in 1857, by Messrs. Hofmann and Witt, to the Government referees on the metropolitan drainage, the question with regard to the pollution sustained by the Thames water is fully examined. The chemical examinations of these able experimentalists began at Richmond and ended at Erith. Numerous analyses were made, not only of the water as found at various intermediate points, but of its suspended matter, and of the lighter mud.*

It may appear an approach to temerity on my part to state, after all that has been said with regard to the impurity of the Thames within London, that the examinations made in the course of all the inquiries prove, that the offensive effluvia is not due to the water itself, but to the peculiar black mud found on the river's banks; moreover, that this mud derives its offensive character from sulphurous oxide of iron—the sulphur of which is acquired, in the first instance, from the action of gas leakage on the oxide of the corroded street mains.

To prove its connexion with this oxide, it will be necessary to trace its passage from the one point to the other. In doing so, I may repeat that the surface of cast-iron, laid in moist earth, soon acquires a coating of oxide, though not with nearly so much rapidity as wrought-iron placed in the same circumstances. An important, but hitherto overlooked, fact is, that the oxide of cast-iron *soon becomes magnetic*, while that of wrought-iron usually remains in the state of inert peroxide (ordinary rust). Consequently, in the one case we have an energetic body which *neutralizes organic odours and rapidly absorbs sulphur;* in the other, a comparatively inert one, which exercises little, if any, influence on the same substances. The fact that both oxides are red, has probably prevented this important difference from being earlier recognized.†

In this property of the magnetic oxide to absorb sulphur, we at once see what becomes of that belonging to the escaped gas, and, equally, that arising from the reaction on the gypseous earth. In a word, the sulphur from each of these sources is rapidly absorbed by the magnetic oxide of the cast-iron, which not only causes the increased corrosion complained of, but, as we shall see, the periodical effluvia emitted from the tidal banks of the river. For example: On absorbing sulphur, the bulk of magnetic oxide is *necessarily enlarged*, while its colour changes from red to blackish grey. No sooner does this enlargement take place, than it *necessarily loosens itself* from the surface of the iron to which it had *previously afforded a protective coating*. By these means, sulphurous oxide becomes mixed with the street

* It is most difficult for any one on the *outside* of gas-works to come at the facts, as to the real amount of gas escape. For example:—One-sixth of all made goes, or ought to go, to light the street lamps, but which is not charged for in the metropolis by meter. Consequently, a wide margin is afforded for a plausible difference of opinion as to the actual amount consumed under this head, each lamp being estimated to burn a given quantity per hour, and is charged for by contract accordingly. It is evident, however, that where the joint escape is large, the earth is liable to receive a proportion of that which is estimated as having gone to the public lamps. The effect of such a state of things would be to give the streets less light, whilst it lessened the nominal amount of gas set down to the charge of leakage. The true reply, therefore, to attempts to call in question the amount of leakage is, to point to the disagreeable state of the street earth, and compare it with that of other towns. Beyond this, an estimate is hardly necessary.

† The members of this joint ought to be kept cylindrical, as then they better maintain their tightness against extremes of temperature than if allowed to be conical. Where a leaky joint occurs, it is usually owing to this defect. If kept cylindrical, the interior member acts as a piston to the exterior one, and hence contraction and expansion are practically allowed for. Of course, these joints require care and intelligent inspection, not only previous to, but while being laid. That such care ought to be exercised on the part of the gas companies is as much due to the public as to their neighbours, the water companies. It has often appeared to me that gas companies were as much liable to action for continuous gas escape as for any other species of public nuisance; and were it not for the prevalence of a belief that tight joints are practically impossible, doubtless such would have taken place ere this. In reference to the early prevalence of this notion as to joints, I may mention that, when gas-lighting was about to be introduced, Sir Humphrey Davy gave an opinion against its practicability, solely on the ground of the impossibility, in his view, of making tight joints. Doubtless this opinion of the great chemist arose from his own notorious lack of mechanical talent, as he was seldom able to manipulate a tolerable joint for the numerous pneumatic experiments of his earlier career. Hence, subsequently, arose his appreciation of that prince of manipulators, Faraday, who, on his engagement at the Royal Institution, soon showed with what ease former manipulatory impossibilities were to be got over.

* Report on Metropolitan Drainage, ordered by the House of Commons to be printed, August the 3rd, 1857.

† Red oxide is usually set down by chemists as peroxide, while black oxide alone is considered to be true magnetic oxide, but which will be found far from being invariably the case. Some of the most energetic magnetic oxide I have seen is as red as peroxide, and was obtained from corroded cast-iron.

earth, while *the surface of the pipe is exposed*, and therefore subjected to fresh oxidation—on which sulphur, from the same sources, is again absorbed.

To this it need hardly be added, that so long as gas escape continues, these effects must follow, until the mains are ultimately so weakened, as to be incapable of bearing the ordinary pressure. Consequently, as this action proceeds, a considerable quantity of sulphurous oxide is continually added to the earth, but from which it soon finds its way, by numerous passages, *into the sewers*. At this stage, however, as it has not taken up all the sulphur it is capable of absorbing, it is comparatively dense, and settles to the bottom of the sewer, where it is not long in acquiring additional sulphur, from the sulphuretted hydrogen in the sewers. By every additional portion of sulphur absorbed, therefore, the oxide becomes lighter, and is consequently carried along with less difficulty, until it is ultimately disembogued into the Thames.*

When I bring to recollection the magnitude of the causes constantly in operation to produce these effects, the only surprise will be that the evil is not manifested in a still more formidable degree; and, were it not for the operation of an equally constant natural law, no doubt it would be so. Meanwhile, I believe I am within bounds when I say that there are above 1500 miles of sewers in the metropolis. Supposing all to be in comparative repair—which is far from being the case—yet, though their bottom may be impervious, the bricks there being laid in cement, their roof is seldom or never quite so; consequently, as the mortar is washed out, there is ample room for the heavier and finer parts of the earth above to find their way through. From inquiries, made of men whose occasional duty it is to examine the sewers, I learn that their upper part is often in a bad state of repair, and, when so, incapable of preventing the ingress of the loose and heavier earth.

If we now consider the enormous length of the cast-iron pipeage laid over these sewers, a large proportion of which is in a more or less active state of corrosion, we shall be at no loss to account for the sulphurous oxide found on the banks of the river,—the only surprise will be, that its quantity is not larger.

From calculations I have made, based on reliable data, I shall again be greatly within bounds when I set down the length of the Metropolitan street pipeage at 4000 miles. This includes gas and water-mains only; service-pipes being omitted, the length of which, though of small diameter must be enormous. Besides gas and water pipes, there are other iron surfaces in the street earth which I do not reckon, though they are equally operated on. By averaging these 4000 miles of mains at the moderate diameter of eight inches, one with another, we shall have, in round numbers, above 1000 acres of cast iron surfaces constantly exposed, in the street earth, to more or less active corrosion.

In addition to the vast amount of oxide of iron arising from this source, a considerable proportion is derived from the streets, by the constant wear of horses' shoes, besides what proceeds, from other causes of a like nature. Though much of the peroxide from these sources finds its way into the sewers, yet, compared with the *magnetic oxide* from cast-iron, the former produces little or no effect, owing to its want of power to absorb sulphur.

Notwithstanding this large area of cast-iron surface, together with the great extent of the sewers, I am far from intending to say that the whole of the iron is in the worst state of corrosion, or that all the sewers are equally pervious to the street earth. But I do say, without fear of contradiction, that there is enough, in both cases, to intimately connect them with the present inquiry, and also to show the strong necessity for practical improvements in jointing the gas-mains. And, let me add, the longer the present system continues, the remedy will be the more difficult.

Unless, indeed, I am successful in proving the nature of the evil from these points of view, I shall have little apology to offer for introducing topics apparently so foreign to the primary objects of my report. To put their relationship beyond doubt, however, I shall now cite a few passages from the reports referred to. These fully show that the evil, as regards the Thames, is by no means due to the offensive quality of the sewerage water *after* arriving there. On the contrary, they prove that its average amount of organic matter—in solution and suspended—is considerably less than in that belonging to other towns, where even no complaints arise on the score of effluvia. Above all, the analyses of the Thames water itself—even of that between the bridges—show it to contain less chemical impurity then that of most other rivers similarly circumstanced; consequently, the water can hardly be in fault.† Even compared with itself, at different points, this is borne out to a most unexpected degree. For example:—According to the analyses of Messrs. Hofmann and Witt, in 1857, the organic matter, chemically dissolved in a gallon of Thames water, taken at

	Grains.
Westminster Bridge—was only	1·94
Same place, following day	1·49
Fulham	1·99
Kew Bridge	1·84

or less than that in many town supplies.

Now, although these figures exhibit little practical difference, yet fractionally, the average runs in favour of the water from Westminster Bridge!

Moreover, the difference in the suspended organic matter, taken at the following points, is perhaps still more striking:—

	Grains.
In the Thames near Kew, it is only	0·71
Do. Westminster Bridge	0·55

in a gallon of the water.

Though it is to be presumed that these gentlemen did not commence their labours with any preconceived notion as to the source of the impurity so loudly complained of at the time; yet, if they had one at all, it was probably favourable to the belief that the effluvia was directly due to the fœcal matter contained in the water itself. The above results, however, must have shown them the erroneousness of this view, for, afterwards, they say:—

The preceding analyses of Thames water, then, show that the amount of dissolved organic matter in it is comparatively small, and varies, moreover, between narrow limits.

And again:—

We have already pointed out the fact that numerous analyses, by very different observers, and extending over a considerable period, have undoubtedly proved that the amount of this dissolved matter is *extremely small*. It has been shown, moreover, that its amount is not very perceptibly greater at London or Westminster Bridge, where the water of the river looks so dirty, than at Kingston, Kew, or Richmond, where it presents so beautifully clear and inviting an appearance. *Why then is it, we may ask, that the effects of these putrefactive decompositions become so intolerable on the banks of the Thames, in the immediate neighbourhood of London, when compared with those perceptible in the higher portions of the river?—Hofmann and Witt's Report.*

Looking at this question from my point of view, I submit that its solution is no longer difficult. Moreover, it leads to the conclusion that, were the whole of the tidal banks of the river similarly circumstanced, as regards access of sulphurous oxide of iron, the same intolerable effluvia that is manifested near London would be equally manifested throughout the river's course, independently of the quality of its water. Hitherto, the solution of this question was almost necessarily involved in obscurity. Indeed, had my own attention not been drawn towards it by these investigations, aided by others in which I have recently shown that magnetic oxides of iron absorb sulphur, in connexion with the purification of gas, it might have still remained in abeyance, as far as I am concerned.

From this unexpected state of the water, I shall now direct attention to the black mud found on the banks of the river between the bridges, as we shall there find the source of the effluvia existing on the *débris* of your corroded pipeage.

The following passage shows the general relation mud has to water:—

The mere *amount of mud* affords no evidence of contamination with sewerage; all rivers necessarily carry along large quantities of mud, which, if the water be agitated in consequence of the current, or by the traffic of steamboats, is prevented from settling, and renders the water turbid. When the bottom of the Thames is stirred up at Kew or Richmond, the water becomes as thick and opaque as at London Bridge; in fact, our analyses show that at Rainham Creek, which the London sewerage probably never reaches, the river at the time this sample was taken was more muddy than at any other part of its course.—*Hofmann and Witt's Report.*

This mud, however, emits no effluvia. I must cite one other proof as to the purity of the water between the bridges, found in an answer made by Mr. Lewis Thompson to a question put by Lord John Manners. It is as follows:—

You stated, did you not, that the upper crust of the water at London Bridge is comparatively pure: Undoubtedly so, almost quite pure water.—*Report on the Thames*, 1858.

And, to show it continues so, I may be permitted to say that, in the course of last year, about the time the effluvia was at its worst, having to draw up a report on the state of the Serpentine,* for the sake of comparison, I made an examination of several samples of Thames water taken between the bridges. Without entering on the details, I may state, generally, that I found them to be of the same pure character as thus indicated by Mr. L. Thompson in 1858, and by Messrs. Hofmann and Witt in 1857.

Some imagine that, notwithstanding the unexpected state of purity, so uniformly exhibited by the water itself, it may be impregnated with noxious gases which, in the course of the ordinary process of analysis, are driven off by evaporation, unnoted. Certainly, such an objection would not be out of place, had no examination been made as to gaseous impurity. As it is, however, the results of several fully bear out all that has been adduced as to the evil not being due to impure gases contained *in* the water.

Though no statement to this effect appears in regard to the samples examined by Messrs. Hofmann and Witt, it is obviously because no other gases were found than those common to water. "What," some may ask, "if there is no sulphuretted hydrogen, then whence arises the effluvia?" To this I reply, confidently, that it is not directly due to the latter gas. Moreover, as a rule, sulphuretted hydrogen is seldom or never found in the Thames water, even in the London area, except within a few yards of the mouth of sewers, and there slightly.

A word or two here may not be out of place with regard to this very much more obnoxious, than, after all, practically noxious gas. Pure water may be made to absorb about three and a half times its bulk of it, though anything approaching this amount never occurs in practice. Even the relatively small quantity found in undiluted sewerage-water, if exposed to the atmosphere, becomes rapidly oxidized, and consequently odourless. One part of this gas is 20,000 times its bulk of ordinary atmospherical air, readily blackens acetate of lead paper, and makes itself disagreeably palpable to the olfactories. In this state of dilution, however, seldom as it occurs, this gas is far from being so noxious as others which less sensibly manifest their presence. After all, it would hardly seem to be in accordance with the usual wisdom of things if this gas, in its ordinary diluted state, were intended to act as a poison on that frame from which it is so inseparable; remembering, that even oxygen *undiluted* would soon act as a poison.

From what has now been advanced, it is obvious that, were the odour complained of to proceed *directly*, as is so generally believed, from the fœcal matters entering the sewers, sulphuretted hydrogen would necessarily be the predominating gas; moreover, we should be able to detect it in the river water by the ordinary tests, nor is anything more easy, where it exists. I can only say, however, that I have been unable to discover it in the Thames water, except slightly at the mouth of a sewer, but *never in the air at the middle, or a few yards from the river's banks;* though, even should it be detected occasionally, the case is not substantially altered.

Let us see, however, what Mr. Goldsworthy Gurney says, on this head, in his evidence to the committee of the House of Commons of 1858. This gentleman's investigations were also made at the request of the Government:

It has been stated (inquires Mr. Percy) that no gases are to be detected in the water? No; but you can catch them at the surface. The gas comes rapidly through to the top; it does not remain as a component part of the water; it does not unite with it.—*Report on the Thames*, 1858.

This is to say, that the offensive gas issues *from the mud beneath*, and passes "rapidly through" the water, but without combining with it. Now, were it sulphuretted hydrogen—apart from making its presence unmistakably palpable—a large proportion would necessarily combine with the water, and therefore not pass through it thus freely.

As already stated, my object in showing the relative purity of the water which flows between the bridges is to prove that the fœtid odour complained of is not derived from that source, but from the *black ferruginous mud lying on the river's margin;* and, looking at the authorities cited, I venture to think that, so far, this is obvious; and equally so, that this peculiar mud is due, in the first instance, to gas leakage acting on the iron pipeage.

I may be told that, as regards the river, this merely amounts to shifting

* From the results of an experiment I had made, on a large scale, at a gas manufactory, it was found that this oxide is capable of absorbing from 50 to 55 per cent. of its weight of sulphur, while, in the course of the process, its original bulk was quadrupled. I do not intend to affirm that these proportions of sulphur are found in the oxide of the Thames mud, but only name the fact to show how large a quantity of sulphur this peculiar oxide is capable of absorbing under favourable circumstances.

† The dilution of the London sewerage water exceeds that of perhaps any other large town. It amounts to 30 gallons per head of the population, while in most towns it is barely 15 gallons per head. Besides, there is here a comparative absence of foul water from chemical and other works; and, from the favourable nature of the levels, the rain-fall is shed gradually off—all of which combine to render the London sewer water comparatively inoffensive in the river.

* Printed by the Government in 1859.

the *onus* from one thing to another, and that, even granting my view to be correct, yet the mud-banks of a tidal river, into which sewers empty themselves, are *always* liable to emit some odour. To a certain extent I admit this is so, in places where sewerage dilution is comparatively small, yet the case of the metropolis is altogether different; for, as I have already said, in other places sulphuretted hydrogen is unmistakably the predominating odour: but, from the rapidity with which it is oxidized, *this gas is never wafted many yards from its source.* Here, on the contrary, while the dilution is comparatively large, the odour is spoken of as not only unlike anything smelled before, but it is manifested at a considerable distance beyond its acknowledged origin. Besides, the sewer effluvium in other places proceeds from the water, and not exclusively from the mud as it does in the Thames. Again, ordinary sewer odour, where it exists, is emitted, more or less, at all temperatures, short of frost. With us, on the contrary, the odour we complain of is known only when the temperature of the moist black mud is raised to from 70° to 90°.

With regard to my own experience of this odour, apart from the examinations I have made of the river itself, my engagements in the committee-rooms of the Houses of Parliament render me tolerably familiar with it in the course of every summer. Though to a chemist it seems slightly phosphorical, yet, to illustrate its nature, I have reproduced it in the laboratory, by means of sulphuret of carbon and ammonia acting on moistened oxide of iron and ordinary clay.

Though chemists as well as others, concur in attributing the evil to the black mud, yet it is so different from anything usually met with, and its constitution so anomalous, that some have imagined the evil might be cured by its removal, under the impression that a substance so exceptional was hardly likely to be reproduced. Of it Messrs. Hofmann and Witt say, however:—

But the *river in the neighbourhood of London* contains an additional and even more formidable element of mischief in the black mud which subsides from the sewerage, and which, in spite of the tidal movements of the river, has accumulated to a considerable degree, and is daily more and more accumulating in the bed of the river; so much so, indeed, that the continuation of the process would lead to the formation of deposits which, in future geological ages, might prove a source of manure, scarcely less valuable than our beds of coprolites, phosphorite, and even guano itself.—*Report of* 1857.

They add, further on—

We cannot but emphatically insist upon it, that the formation of this mud deposit in the river, appears to us to be by far the most serious evil which results from the discharge of the London sewerage into the river. We cannot too strongly urge this point upon public attention. The evil is not confined to the river; it would appear that *similar deposits are forming also in the sewers themselves*, notwithstanding the improvements which have taken place of late in the construction, cleansing—in fact, in the whole management of the sewers.—*Report of* 1857.

Again, in the concluding paragraph of the summary of their report, they recur to this black mud, as being all-important. They say—

The *intensity of this putrefactive decomposition*, which the organic matter present in the water undergoes within the metropolitan area, arises from the constant supply of putrescible matter, partly by the influx of the sewerage, *but more especially by the vast accumulation of black sewerage mud* which has gradually collected in the bed of the river.—*Report on Drainage*, 1857.

Though the "organic matter" present in the water "within the metropolitan area" is here spoken of as the cause; yet we have it, on these gentlemen's own authority—in the analyses already cited, in the same report—that the organic matter is exceedingly small. It is also within my own knowledge, that it is not more than that entering into the composition of water supplied to many towns for domestic use, and therefore obviously inadequate to produce the effluvium complained of, even without pressing decomposition into the service.

Had these able chemists obtained the clue to the circumstances under which this black mud became present, they would have scarcely concluded their report with this portentous generalization about "putrefactive decomposition," by way of accounting for the effluvium.

In the numerous analyses made in the course of their investigation, I do not observe any special one of this ferruginous mud, which leads me to suppose its importance became evident only at its close. I do not refer to the suspended mud, of which there are several analyses, but to that black, heavy matter, consisting of carbon, magnetic oxide of iron and sulphur found at the bottom of the sewers, and which, on finding its way to the river, emits its odour only in the hottest weather. Its finer particles are often seen, at high tide, floating over the outlet of a sewer, as a black, oily-looking matter—though the odour is only given out in summer.

Before concluding, the following extract sufficiently shows that the iron found in this mud is in the state of protoxide, and, consequently, magnetic; and, from what I have already advanced, its origin need be no longer doubtful. In the course of the inquiry of 1858, one of the witnesses (Mr. Lawes, chemist, one of the Sewerage Commission) is asked by Mr. Tite—

"It has been suggested here that the sewerage of London *abounds so much in protoxide of iron*, that it is rendered valueless as a manure, even supposing that it were carried on to the land without any cost to the farmer. As a chemist, is that your opinion?"—"No; certainly not."

"Why?" continues Mr. Tite, "the quantity of iron contained in the sewerage of London is very considerable indeed *; the committee have had experiments made, and after the mud has been dried, the magnet, when applied, has been covered with particles of iron, and it has been suggested that an enormous quantity being carried down by the line would render the sewerage of London less valuable than the sewerage of Leicester, which does not contain the same *enormous quantity of iron*. Do you think, as a chemist, that the quantity of iron so retained would diminish the value of the refuse matter of London as a manure?"—"No, I do not." "Will not," continues Mr. Tite, "the protoxide of iron be mischievous to the land?"—"I cannot conceive," replies Mr. Lawes, "that the protoxide of iron can exist long; it must become the peroxide of iron, which is harmless in the quantity in which it would be used."

"Is your acquaintance with that matter experimental, or only theoretical?"—"Theoretical. I have never treated the London sewerage experimentally."—*Report of* 1858.

Certainly Mr. Lawes' opinion on this matter must have been theoretical, for, instead of the tendency being to convert protoxide in to peroxide, as he says, it is, in practice, altogether the reverse. In short, my experience shows that, at ordinary temperatures, peroxide is liable to be converted into magnetic oxide (protoxide).† However, its very existence in this mud, might, one would say, have led to some inquiry, or inference, as to its origin. It could have scarcely come there accidentally, it being too valuable to throw away, while all know that it is not indigenous to the soil. However, the distinction I have pointed out as to the nature of the oxide arising from the corrosion of cast iron, as compared with that from wrought iron, has not, I believe, been observed hitherto, therefore its origin in the mud was involved in more obscurity.

Having dwelt on this part of the subject longer, perhaps then the nature of this report may appear to warrant, I shall conclude now by briefly stating the effects of the sulphurous oxide when exposed on the tidal banks of the river.

Unless highly surcharged with sulphur, this oxide emits no odour at an ordinary temperature. It is only, therefore, when that of the atmosphere has reached 70° or 80° of Fahrenheit, as happens in the summer months of June and July, that the mischief begins to be perceptible. It is also to be remembered that the mud itself being black, it attains at such times a much higher temperature than the atmosphere, from its increased powers of absorbing heat.

When all these conditions are coincident, the fœtid gas emitted from the ferruginous mud is a mixture of carbonic oxide with sulphuret of carbon, the sulphur of which, unlike that of sulphuretted hydrogen, being so tardily oxidized, its peculiarly offensive odour is carried considerably beyond the place of its origin.* I trust it will now be abundantly evident that, in the emission of this peculiar gaseous mixture from the blackened mud, we have the sclution of all the mischief so loudly complained of, as regards the Thames; and that it is proximately connected with the gas leakage going on in the streets.

Once more, let me apologize for the length at which I have dwelt on this part of the subject. I have done so, however, in the belief that, unless the evil be clearly shown to affect the public, its remedy will be longer sought for on the part of the company. Let me add that I write in no hostility to the gas companies; on the contrary, I believe that whoever is instrumental in effecting a reduction of their leakage will prove their best friend. I have also been careful throughout to avoid exaggeration, or to make any statement without thorough consideration.

That, as to the impurities found in the gas supplied to the City, is taken as I found it in the public prints, but without personally vouching for the strict accuracy of the figures. Judging, however, from the experience of those employed in testing, they are probably not far from the truth. As the case put forward in the present Report is not made to rest so much on the impurity of the gas itself, as on the amount of its leakage, which subsequently generates injurious matter on being absorbed into the earth, I have not considered myself called on to deal more fully with the question of its purity on leaving the manufactory.

I have also avoided any expression of opinion as to the effects of gas leakage on the public health, as being specially within the province of another profession, though, perhaps I may be allowed to state, generally, that the inhalation of gases of this nature, even in imperceptible quantity, produces a diminution of vital action, and consequent debility.

Summary of Conclusions.

The following conclusions are arrived at, after carefully collating the preceding experiments and observations:—

First.—*A.* Cast-iron piping, laid in the earth which constitutes the natural soil of the metropolis, and receiving moisture derived from rain only, is calculated to maintain itself in practical efficiency for at least a century. *B.* Though the surface of cast-iron, in these circumstances, soon acquires a primary coating of oxide, a much longer period is required to form an additional one of equal thickness, and a greatly increasing period to form a third; each increment of oxide acting as a partial barrier to the formation of another, until eventually a hard protecting incrustation is formed, which adheres to the pipe, and practically prevents the passage of moisture to the surface of the metal, thereby greatly preserving it from farther corrosion. *C.* From this it will be obvious that improved paving and drainage conduce to extend the duration of street piping, each having the effect of preventing the passage and lodgment of moisture beneath the surface.

Second.—*A.* Cast-iron, if laid in earth liable to be moistened with impure water from street gutters, corrodes sooner than if laid in earth subject to moisture from rain alone—the degree of corrosion depending on the character of the impurity. *B.* In small and ill-drained streets, where the population is dense, and where fouled water is frequently discharged on the surface, corrosion is liable to proceed with more activity in such districts than in those of a better class, where the streets are usually dry except in wet weather. *C.* It is therefore evident that the degree of corrosion will vary with the character of the locality; and, therefore, in well-drained streets, cast-iron ought to continue in a better state of preservation than if laid in similar earth, even in a country road.

Third.—*A.* Cast-iron, laid on a clay bottom, corrodes more rapidly than if laid in loose earth; because the water percolating from above, or derived from leakage, is arrested by the clay, and consequently lodges round a section of the pipe. As the London clay contains gypsum, which is taken into solution by the water, corrosion, under these circumstances, is additionally active where the two metals, iron and lead, are present. *B.* Under the same circumstances, the corrosion is greatest at the joints, a galvanic action being there set up between the lead and the iron, the one acting as the positive, the other as the negative element; while the water, or even moisture with gypsum in solution, becomes a good conducting medium. This action has the effect of converting the lower portion of the socket of the pipe into a species of plumbago.† Cinders, where in contact with piping, exercise a similar effect, they acting as the negative element whenever they happen to be in the clay and in contact with the iron. Thus isolated parts of mains are often found "honey-combed," from contact with clusters of cinders in a clay bottom, though the cause is generally set down to some local defect of the metal itself. Pipeage laid in the London earth, however, is not so much liable to damage from this cause as in manufacturing districts. *C.* Corrosive action of this character, when once set up, is calculated to propagate itself; for, should the original cause be removed, those parts of the iron left in the state of plumbago act as the negative element to the surrounding metal.

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* From what I have said, the only marvel is that the iron is not greater.

† Strictly, protoxide consists of one atom of oxygen to one of iron (Fe. 0), though it has never been found isolated. Magnetic oxide, as ordinarily found, consists of three atoms of iron to four of oxygen (Fe. 3,04). This oxide is meant above, when speaking of protoxide, though it is not strictly so—its chemical name being Ferroso-ferric oxide. Peroxide consists of two atoms of iron to three of oxygen (Fe. 2.03). The relatively smaller quantity of oxygen in the former oxide gives rise to the most marvellous difference in its properties over the peroxide.

* I have been able to collect this gas in the laboratory, from the ferruginous mud taken in winter, on raising its temperature to about 90°. Its smell was identical with that emitted from it, when lying on the banks of the river in summer.

† There is nothing approaching to theory in the above; it is, on the contrary, a fact which may be observed daily, though the cause is often overlooked. For example:—The lower end of old iron railings are always observed to be the most reduced by corrosion just where the lead of the joint is in contact with the iron. Were the moisture they are subject to in the open air of a less pure character than that from rain, the corrosive action would be far more rapid.

Fourth.—*A.* None of the preceding causes are nearly so destructive to cast iron as that state of the earth arising from gas leakage. For example, its continuance renders all the surrounding moisture highly alkaline, and thereby converts it into the best possible conducting medium for promoting the galvanic action that inevitably ensues between the lead and the iron at the joints. Under these circumstances, corrosion takes place with greater rapidity than where the moisture contains only earthy matter in solution. *B.* Gas leakage, as already shown, has the additional effect of preventing the permanent formation of a protecting incrustation of normal oxide on the body of the pipe, and consequently its metal is left open to continued attack from the same cause.

Fifth.—*A.* Where pipeage is laid in clean earth, some varnishes afford a better protection against corrosion than others; though, looking at the exterior of the mains alone, varnishes are mere palliatives; and I would rather trust to the protection afforded by a firm incrustation of natural oxide than to any varnish I know of. *B.* On the other hand, where the water conveyed is almost entirely free from lime-salts in solution, and where organic matter predominates, some varnishes, properly applied, afford a very beneficial protection against interior corrosion. The quality of the New River water, however, renders such a protection unnecessary. *C. No varnish known to me affords even a temporary protection to cast iron, if laid in moist earth that is subject to permanent gas leakage.* I have the honour to be yours faithfully,

192, *Euston Road, London, March*, 1860. THOMAS SPENCER.

FIRE-BRICKS.

Under the head of "Pottery," Dr. Sheridan Muspratt, in his recently completed work on "Chemistry," says: "Glass pots and retorts for the production of gas are, perhaps, the largest vessels at present constructed of fire-clay. The fire-clay retorts constructed by Messrs. Joseph Cowen and Co. of Blaydon Burn, near Newcastle-on-Tyne, are sometimes as long as 10 feet, with an internal width of 3 feet, and are constructed in one piece. In use they are found to be four times as durable as iron. The material which furnishes these fire-proof wares consists of seven varieties of clay belonging to the coal formation, and which are found in the neighbourhood of Newcastle-upon-Tyne. They occur below the coal, and are worked with them from the same pit. In colour they are greyish brown, and full of vegetal remains. The analysis is as follows:—

	1.	2.	3.	4.	5.	6.	7.
Silica	51·10	47·55	48·55	51·11	71·28	83·29	69·25
Alumina ..	31·35	29·50	30·25	30·40	17·75	8·10	17·90
Oxide of iron	4·63	9·13	4·06	4·91	2·43	1·88	2·97
Lime.....	1·46	1·34	1·66	1·76			
Magnesia ..	1·54	0·71	1·91	trace	2·30	2·99	1·30
Water and organic matter ..	10·47	12·01	10·67	12·29	6·94	3·64	7·50

"By this it will be seen that the amount of silica in No. 2 is to the total amount of the bases as 100: 85, while in No. 6 it is as 100: 16. These clays are mixed together in certain proportions, according to the purposes for which they are intended. The clay is not suspended in water, the coarser particles being ground into the mass together with the addition of one-fourth part in weight of sawdust.

"The gas-retorts require to resist the sudden changes of temperature, which they undergo in the processes of firing and recharging, and average 3 inches in thickness to give them durability. These circumstances, combined with the D form of the retort, would inevitably cause them to crack, if the mass was not rendered excessively porous by the destruction of the sawdust in the firing. Powdered coke may be used for the same purpose, while the loss of gas from the porosity of the mass is prevented by the layer of carbon deposited on the interior surface during the operation. The retorts are either moulded and built up by hand with the plastic material, or formed by pressure in machines, somewhat similar to those described for pipe-making; but under pressure so enormous as sometimes to rend asunder iron cylinders between 2 and 3 inches thick. The drying and burning proceeds afterwards very slowly to avoid all chances of bursting of the retort when used. The firing lasts fourteen days, and the retorts are of a pale yellow colour.

"Newcastle-upon-Tyne also carries on an extensive trade in the manufacture of fire-bricks from the same clays above enumerated, and the preparation of which is as follows:—The clays, after exposure to the atmosphere for some time, are removed to the clay-mill, and ground up with fragments of the same clay, previously burnt, from whence it is taken to the pug-mill for mastication before it is taken to the moulder. The bricks are then laid out to dry, and afterwards burnt in a kiln about 15 feet long by 14 feet broad, and 10 feet high. Each kiln will burn about 15,000 bricks at once. The operation of firing lasts five days. The bricks are placed on their edge lengthwise in the kiln. Stone bricks of a very valuable kind, and used in the construction of the arches of reverberatory furnaces employed at Swansea in smelting copper ores, are extensively manufactured at Neath, in Glamorganshire. The materials of which the bricks are composed are obtained from the neighbourhood; they are subjected to a coarse crushing process, under an edge-stone, and after mixing with a little water, are compressed into form by machine, the coarseness of the mass rendering the moulding by hand impossible. This brick is fired in the ordinary way, but resists the action of intense heat better than the Stourbridge clay-brick. It expands more by heat, and does not contract to its original dimensions. The analysis of the three materials composing the mass is as follows:—

	From Penderyn.	From Dinas.	
Silica	94·05	100	91·95
Alumina, with traces of oxide of iron	4·55	traces	8·05
Lime and magnesia	—	,,	traces
	98·60	100	100·00

These bricks may therefore be called siliceous or stone bricks, and will no doubt prove admirably adapted for the construction of many kinds of chemical furnaces. A red fire-brick is likewise manufactured at Windsor, the analysis of the clay from which it is prepared being as follows:—

Silica	84·65
Peroxide of iron	4·25
Alumina	8·85
Lime	1·90
Magnesia	·35
	100·00

Or, in mechanical mixture, about 70 sand and 30 parts clay."

SINGULAR DEATH FROM FOUL AIR.—A very lengthened investigation was held on the 18th inst., before Mr. Langham, deputy-coroner for Westminster, at St. George's Hospital, concerning the death of James Holohan, a workman employed by the Imperial Gas Company in laying down a new 36-inch main, in St. George's Place, Knightsbridge. The pipes, after being laid down in the trench dug for them, are securely jointed on the outside with lead and tarred rope, and the interior of the joints are filled in with Roman cement. The deceased and a boy named Carron were employed in cementing the joints. For this purpose they had to crawl along inside the pipes with candle, cement, and other materials for the work. On the previous Friday afternoon they went into the pipes as usual, and, according to the boy's evidence, they both complained of a very strong and overpowering smell of gas, deceased making the remark that they must work through it. They continued on till they were 15 pipes up, each pipe measuring 12 feet in length (making 180 feet from the entrance, which could not be seen from the inside, owing to curves), when the boy's head began to ache, and he complained of feeling stupid. Shortly after he fell down, and was picked up by the deceased, but he was unable to stand, and deceased began to help him out. After getting a short distance towards the mouth of the pipes he told the boy to lie down, as he must save himself. Deceased had hardly moved from the boy when he fell overpowered, and the boy, who was flat on his face at this period, called for help. The other workmen ultimately succeeded in dragging them out with ropes. Holohan was quite dead on arriving at the hospital, but the boy was recovered. The medical evidence showed the deceased to have been a very healthy man, and that his death was occasioned by foul air such as might be occasioned by coal gas. The jury returned a verdict that "the deceased died from accidental death from excessive inhalation of sulphuretted hydrogen gas," and added that there ought to be more control over the men, and that they should not be allowed to go more than five or six joints up at a time as the pipes are finished. Mr. Hersey, the chief inspector of the company, said he would attend to the recommendation.

Advertisements.

COUNTY and General Gas Consumers COMPANY (LIMITED).—Works at Chertsey, Lea Bridge, Northfleet, Pembroke, Pembroke Dock, Ware, and Walton-on-Thames, producing a gas rental of about £6500 per annum.

Established for the erection of gas-works in provincial towns, or the purchase or leasing of existing works on equitable terms. Application to be made to the Engineer to the Company, Mr. H. P. STEPHENSON, 58, PALL MALL.

SURREY CONSUMERS GAS COMPANY.

Notice is hereby given that the HALF-YEARLY ORDINARY GENERAL MEETING of the Shareholders of the above Company, will be held at the London Tavern, BISHOPSGATE STREET, on Thursday, the 4th day of October next, at three o'clock in the afternoon precisely.

The Transfer Books will be closed on Monday, the 14th of September, inst., until after the Meeting.

WM. P. BODDY, Secretary.

Offices, Rotherhithe, Sept. 17, 1860.

CAST-IRON Retorts, Socket Pipes, with Syphons and all requisite Connexions, Lamp Columns, Wrought Iron Tubing, Valves, Street Lamps, Sight Holes, Furnace Doors, Ash Pans, Charging and Coke Shovels, Iron Pails and Coke Barrows, Cross Bars, Fire Pots, Pumps, Iron Borings.

PURIFIERS, CONDENSERS, and SCRUBBERS erected complete, or the materials supplied; with every description of goods in use by Gas-Works, in stock, on wholesale prices, at

Mr. LYNCH WHITE'S,
Old Barge Iron Wharf, Upper Ground Street, LONDON.

TO GAS COMPANIES.

STOKERS' GLOVES' 11s. per Dozen.
S. CARPENTER, 3, BOW COMMON.

ROBERT MACLAREN and CO., EGLINTON FOUNDRY, GLASGOW, Manufacturers of all sizes of Cast-Iron Main Pipes, by an improved Patent, General Ironfounders, Gas Engineers, and Wrought-Iron Tube Makers.

WANTED, A GAS MANAGER.

WANTED, for a small Town in the South of Ireland, an experienced sober Man as GAS-FITTER and MANAGER. He must be capable of keeping Accounts, understand the manufacture of Gas, the fixing of Retorts, and Fitting generally.

Salary £50 per annum (with prospect of increase), and House and Garden at a nominal rent.

Applicant to address in his own handwriting to W.T., Office of the JOURNAL OF GASLIGHTING.

FLEXIBLE GAS TUBING,
VULCANIZED INDIARUBBER HOSE-PIPES,
WASHERS FOR STEAM-JOINTS, &c.

JAMES LYNE HANCOCK begs to inform the trade he has considerably improved the manufacture of his FLEXIBLE TUBING, both PLAIN and GLAZED. Made all sizes in 60 feet lengths.

INDIARUBBER GAS BAGS, fitted complete with Stop-Cocks and Tubes.

All orders to be addressed to JAMES LYNE HANCOCK, Vulcanized Indiarubber Works, Goswell Road, (opposite Spencer Street) LONDON (E.C.).

M. SHEEN, Gas and Railway Lantern Maker, 90½, Holborn Hill, begs to inform Managers of Gas-Works, &c., that she continues to contract and supply Lanterns on reasonable terms, and keep them in repair by the year.

BELGIAN CLAY RETORTS.

ALBERT KELLER, Ghent.—The removal of the import duties on Earthenware permitting the entry of Clay Retorts into England, Albert Keller, of Ghent, begs to draw the attention of the Gas Companies of London, and other Cities, to the very superior quality of the RETORTS manufactured by him. They can be made of any size, in one piece, and of any form. The price will be in proportion to the weight, and very moderate in comparison to their value.

Communications, addressed to ALBERT KELLER, GHENT, will receive immediate attention.

CAUTION.

TO GAS-METER MANUFACTURERS AND OTHERS.

THE Undersigned hereby caution Meter Manufacturers and others against infringing the exclusive right of the Undersigned to the use of the Screw Adjustment for regulating the Height of the Overflow-Pipes in Wet Gas-Meters, as described in the Specification of the Letters Patent granted to Crosley and Goldsmith on the 19th of April, 1856; as well as against infringing any other portions of that or any other Patent of the said William Crosley; and

NOTICE is further given, that all Infringers of the said Inventions, or any portions of them, will be proceeded against.

CROSLEY & CO.,
103, SOUTHWARK BRIDGE ROAD,
LONDON, Aug. 29, 1859.

GRAY, BAILEY, and BARTLEET,
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Manufacturers of Chandeliers and Gas Fittings, and Patent Steam Gauges.

ADDISON POTTER,
WILLINGTON QUAY,
NEAR NEWCASTLE-UPON-TYNE,
Manufacturer of Clay Retorts, Fire Bricks, and every description of Fire Clay Goods.

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MANUFACTURERS OF EVERY DESCRIPTION OF
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Beg to draw the attention of Engineers and Managers of Gas Works to the superior quality of the Article they manufacture, both in respect of the iron employed, and the perfect manner in which it is welded; in proof of which they can refer to the testimonials of the most eminent Gas Engineers, and the experience of the principal of the large Gas Companies of the kingdom.
Orders promptly executed.

TO Mr. BENJAMIN WHITEHOUSE,
GASHOLDER MAKER,
WESTBROMWICH, NEAR BIRMINGHAM.
Sir,—I feel great pleasure in expressing my satisfaction at the manner in which you discharged your duties as CONTRACTOR for the TELESCOPIC GASHOLDER, 150 feet diameter and 60 feet deep, erected at this Company's Nine Elm Station in 1857. From that period to the present I have closely watched its working, and have never found the least defect either in workmanship or material.
During the recent heavy gales the Gasholder, although containing upwards of 1,000,000 cubic feet of Gas, showed no perceptible indications of its influence, but worked as freely and easily as usual.
RICHARD JONES.
Engineer to the London Gaslight Company.
Vauxhall, London, Nov. 9, 1859.

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PROVIDENCE IRON WORKS,
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Main Laying and Gas-Works erected complete.

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DEPÔT for STOURBRIDGE AND NEWCASTLE FIRE-BRICKS, LUMPS, TILES, and CLAY,
and every Article suitable for
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EIGHTON MOOR GAS COALS.—Parties wishing to be supplied with these first-class Gas Coals will please to apply to Mr. MATTHEW NESBIT, EIGHTON MOOR OFFICE, NEWCASTLE-UPON-TYNE. These coals are well known as among the richest in gas, and working the roundest on the River Tyne. They are extensively used by metropolitan gas works.

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AND CONTRACTOR,
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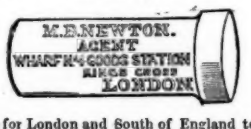

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N.B.—A few Retorts of each size, and a large stock of Bricks and Lumps, always on hand at the above Wharf.

CANNEL and COAL of the best descriptions for making GAS and COKE.
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GAS CANNEL, 17s., 15s. 6d., and 14s. per ton.
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All free on board Vessels in Liverpool.
Handpicked Cannel and Coal about 10 per cent. additional. Concession in prices made for large quantities.
GAS APPARATUS of all descriptions, and on the most approved principles; also Purifying and other materials supplied.
ANALYSES, PLANS, and ESTIMATES, and other information required, and the highest references furnished on application.
CONTRACTS for Materials and Works entered into.
No charge made for Superintending Shipments, Preparing Bills of Lading, or passing Entries.
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Gas Stoves, Gas Baths, Gas Cooking APPARATUS, warranted the best in England, at PHILLIPS'S, the original inventor and manufacturer, and general gas-fitter, &c., 55, Skinner Street, Snow Hill, LONDON, E.C.
PATENT SAFETY ATLAS CHANDELIERS, Sun and Star Burners, Outside Lamps, Patent Reflecting Lamps, Portable Coppers for either Gas or Fuel. Iron Tube and Fittings. Best quality for Gas, Steam, or Hot Water, &c. &c.

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Manufacturer of
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GAS APPARATUS.—W. M. has an extensive assortment of patterns for Purifiers from 4 feet to 15 feet square, also round ones from 4 feet to 10 feet diameter; Scrubbers, Condensers, Washers, Columns, Girders, and Tripod Patterns, suitable for Gasholders, from 10 feet to 150 feet diameter, either Single-lift or Telescope. Contractor for Gas Works of any Magnitude. Designs, Specifications, and Estimates furnished.
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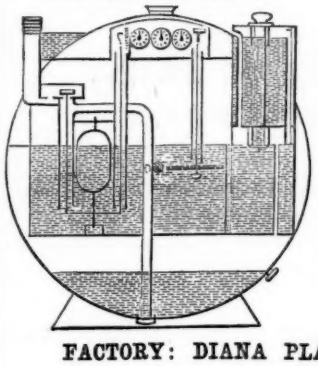
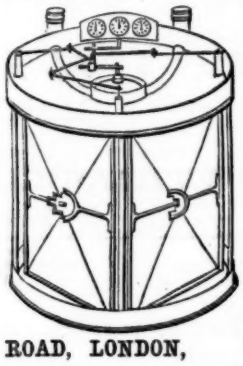
PIPES and VALVES, for Gas and Water, from 2 inches to 48 inches bore.

PATENT WET METER.



N. DEFRIES,
CONSULTING GAS ENGINEER,
Inventor and Patentee
OF
WET GAS-METERS,
WITH SELF-ADJUSTING WATER-LINE;
DRY METERS,
GAS-HEATING BATHS, OVENS, STOVES,
GAS FIRES with INDESTRUCTIBLE FUEL,
&c., &c.

PATENT DRY METER.



FACTORY: DIANA PLACE, FITZROY SQUARE. OFFICE: 406, EUSTON ROAD, LONDON,
Eight Doors from Factory.

Attempts having been made to construct Self-Supplying Apparatus to Wet Gas-Meters upon the Bird Fountain principle,—which, although unerring to supply water in the open atmosphere, has not wholly succeeded so as to be relied upon when enclosed in a Gas-tight Meter Case,—N. DEFRIES begs leave most respectfully to acquaint Gas Companies, and the Public in general, that he has constructed his PATENT WET GAS-METER upon a method entirely different, being founded on the well-known principle of the self-acting supply of the Oil Lamp, which has never been applied for the adjustment of the Meter Water-Line before, and which, by the admission of external air to a chamber sealed from Gas, will never fail to faithfully perform its required function. They are of the very best materials and workmanship, will stand more pressure than is required as the test for soundness by the New Act, are guaranteed to prevent surreptitious burning without detection, and will be kept in repair free of charge for seven years.

N. DEFRIES'S CELEBRATED DRY METERS,

of which more than 80,000 are in use in Palaces, Churches, Chapels, Royal Dockyards, Club Houses, Public Offices, and other Buildings throughout the Empire and Continent, which have done so much in checking surreptitious burning, and simplified the fitting up of Gas.
To remove any doubt of accuracy of measurement his Meter for 1500 lights, in use upwards of ten years at the Royal Italian Opera, until that Building was destroyed by Fire, was long afterwards dug out of the burnt ruins, then tested by the Chartered Gas Company in the presence of George Lowe, Esq., F.R.S., and other Chief Officers, and found inflexibly correct. Also, on the 9th of June, 1858, at the Western Gas-Works, his Meter for 150 lights, after considerable use, was doubted, and subjected to the most variable tests—from the full lighting to a single Jet—and in each case, as in other instances, accuracy was finely indicated.
As to durability, his two large Meters at the Thames Tunnel have been in use night and day for upwards of twelve years—one continuation of dark hours—subjected to the wear and tear of seventy-five years as compared with the ordinary business hours of using Gas above ground.

LORD REDESDALE'S SALE OF GAS BILL.

All Meters constructed by N. DEFRIES are guaranteed to pass the Provisions of the Standard.

No alteration has been necessary in the Meters he continues to supply to the Chartered, Imperial, City of London, Equitable, and other large Companies, his accustomed range of 1 per cent. over and under meeting all the desired requirements; whereas, by the New Act, a greater departure from accuracy—viz., 2 per cent. fast to 3 per cent. slow—is permitted.

TO GAS COMPANIES AND CONTRACTORS.

FOR Sale, several lengths of Hydraulic MAIN, 14 inches diameter and 6 feet 9 inches long, with 7 holes for DIP-PIPES.

Also 4-inch ASCENSION-PIPES, and 3-inch ARCH and DIP-PIPES, and RETORT MOUTHPIECES, all in excellent condition, and will be sold at a very low price, and delivered, if required, at any Railway Station in London.

To be seen, on application to the ENGINEER, at the Equitable Gas Company's Works, Lupus Street, PIMLICO.

BENJAMIN GIBBONS, Jun.,
DEEPDALE FIRE-CLAY & BRICK WORKS,
Near DUDLEY,

Manufacturer of every description of Fire-Bricks, Lumps, Quarries, Shields, Flue Covers, &c., to any size or shape required.

FIRE-CLAY RETORTS,
TO MODEL OR DRAWING.

B. G. begs to call the attention of Gas Companies to his Fire-Clay Retorts, which have been used with great satisfaction in some of the largest Gas-Works in the Metropolis and many Provincial Towns in England.

References given, if required.

JOSEPH WILLCOCK
(late BARLOW and CO.),

Mechanical and Architectural Draftsman, Designer, Serveyor, an Lithographer to Gas Engineers and Gas Apparatus Manufacturers, formerly Superintending Engineer at the largest Gas Apparatus Manufactory on the Continent.

Patent and Designs Office, 89, Chancery Lane, LONDON, W.C.

GEORGE ANDERSON, Gas and
CONSULTING ENGINEER,
104, LEADENHALL STREET, LONDON (E.C.).

DIRECT-ACTING GAS-EXHAUSTERS,
supplied either with or without Steam-Engines and Boilers.

FOUR-WAY DIAPHRAGM VALVES,
one of which answers the purpose of THREE ordinary Valves, as applied to Purifiers, or in shutting off and passing Station-Meters, Governors, or other apparatus, while the Connecting-Pipes are also much simplified.

RETORT SETTINGS,
designed to be heated by Tar alone, and with a total absence of Smoke.

Illustrated circulars, giving references and every information, may be obtained on application as above.

WOLVERHAMPTON RETORT WORKS.
ESTABLISHED **1840.**

JOHN EUNSON AND SON,
GAS ENGINEERS, AND MANUFACTURERS OF CLAY RETORTS,
AND FIRE GOODS IN GENERAL,
WOLVERHAMPTON.

Retort Mouthpieces, Bolts, Nuts, and every description of Wrought-Iron Work.

HENLLIS WORKS,
NEWPORT, MON.,
ESTABLISHED **1842.**

CYRUS HANSON,

Manufacturer of CLAY RETORTS, and every description of Fire Bricks. Retort Mouth-Pieces, and Wrought-Iron Work.

Agent at BRISTOL, Mr. GEORGE FRY, WELCH BACK.

HARRIS and PEARSON,
PROPRIETORS OF
BEST CLASS-HOUSE POT AND CRUCIBLE CLAY.
MANUFACTURERS OF
FIRE BRICKS, GAS RETORTS, &C.
AMBLECOTE FIRE CLAY AND BRICK WORKS,
STOURBRIDGE.
Late in the occupation of I. and W. King.
Originally J. Pidcock, Esq.

NB. A quantity of best Clay Retorts in stock, viz.—Circulars, 14 inches, 15 inches, 16 inches.
D's, 16×12, 15×14, 20×16, 15×18.

WEST and GREGSON, Gas-Meter
MANUFACTURERS, &c.
UNION STREET, OLDHAM.

Station and Experimental Meters, Gas Pressure Registers, Gauges, Experimental Gasholders, Governors, Slide Valves, &c. &c.

W. and G. would respectfully call the attention of Gas Engineers and Managers to their Station-meters, having made and erected the largest in use at the present time, two of which may be seen at the Stockport and Liverpool Gas Works, on application to the respective Engineers.

WALTER FORD,
LATE
PADDON and FORD,
GAS-METER AND APPARATUS WORKS,
GRAY'S INN ROAD, LONDON.
MANUFACTURER OF WET AND DRY GAS-METERS, STATION-METERS, GOVERNORS, &c. &c.

A large number of **STATION-METERS,** up to 80,000 feet per hour (being by far the largest in use), and **GOVERNORS** for **MAINS,** up to 24 inches, have been constructed by Paddon and Ford. These Meters and Governors possess peculiar advantages as regards strength and freedom of action.

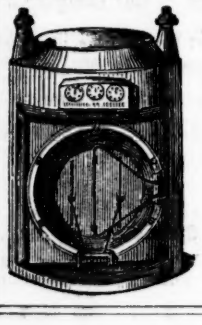
Sole Manufacturer of **PADDON'S PATENT STREET-LAMP REGULATORS,** for insuring any required consumption. These Regulators are in general and increasing use, and references can be given to Gas Companies who use them for every Lamp.

LIVESEY FIRE-CLAY WORKS,
NEAR BLACKBURN, LANCASHIRE.

ORLANDO BROTHERS,
MANUFACTURER OF PATENT CLAY RETORTS,
AND EVERY DESCRIPTION OF
TUBULAR GLAZED SEWERAGE PIPES, BENDS, JUNCTIONS, ETC.
FIRE-BRICKS, TILES, BLOCKS, AND CHIMNEY-TOPS.

WILLIAM SUGG,
MANUFACTURER OF
PATENT DRY AND WATER GAS-METERS, TEST GASHOLDERS, AND APPARATUS,
"EVANS'S" PHOTOMETERS,
Experimental Meters, Minute Clocks, &c., Station Meters and Governors,
STREET-LAMP GOVERNORS AND LAVA BURNERS,
19 and 20, MARSHAM STREET, WESTMINSTER.

JAMES MEACOCK,
PATENT DRY AND WET GAS-METER MANUFACTURER,
7, SNOW HILL, AND 16, WEST STREET, LONDON.
ESTABLISHED 1836.



J. M. invites attention to his Improvements in EXPERIMENTAL WET GAS-METERS, by which he renders impossible any Leakage from the Stuffing-Box.

These METERS are GUARANTEED to meet all the Requirements of the SALE OF GAS ACT

GOVERNORS, STATION-METERS, PHOTOMETERS,
EXPERIMENTAL TESTING GASHOLDERS, HIGH-PRESSURE GAUGES,
AND ALL APPARATUS IN USE AT THE GAS MANUFACTORY.

CROSLEY & GOLDSMITH'S

PATENT SELF-ADJUSTING & COMPENSATING GAS-METERS

CANNOT BE OVER OR UNDERCHARGED WITH WATER,

and they consequently register the quantity of Gas consumed with greater accuracy than Meters in which the Water-Line is variable.

MANUFACTURED BY

CROSLEY & CO.,

GAS-METER MANUFACTURERS,

103, SOUTHWARK BRIDGE ROAD, LONDON.

N.B. The Patent Self-Adjusting and Compensating Apparatus may be applied to the ordinary Meter.

Manufacturers of LOWE'S PATENT MOTIVE-POWER METER, for situations where there is an inadequacy of pressure to supply the special requirements of certain consumers in low grounds during the day or night.

Also, Manufacturers of EXPERIMENT METERS, GASHOLDERS, GOVERNORS, MINUTE-CLOCKS, PHOTOMETERS, &c. &c., similar to those used by Mr. King, of Liverpool.

C. and Co. are the only house in the trade which has for years manufactured Meters according to the standard measure set forth in the 2nd Section of the "Sale of Gas Act," and which also comply with the rules laid down in the Section for testing meters. Purchasers of C. and Co.'s Meters may therefore be secured against any additional expenses being incurred in order to adapt their Meters to the requirements of the new Act.

WILLIAM PARKINSON AND CO.,

(SUCCESSORS TO THE LATE SAMUEL CROSLEY,)

COTTAGE LANE, CITY ROAD, LONDON, E.C.

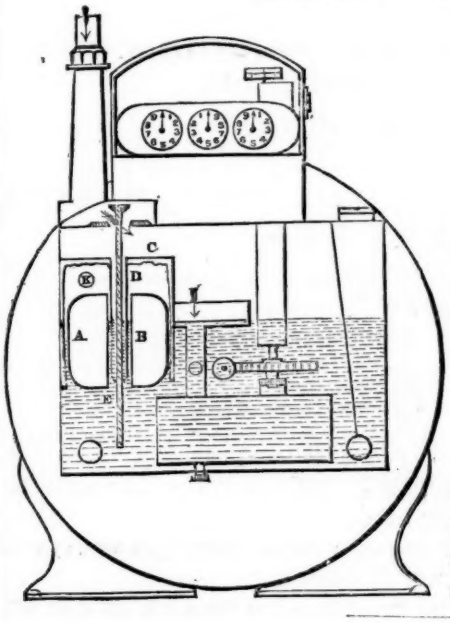
Established 1816.

PATENTEES AND MANUFACTURERS OF

STATION-METERS & GOVERNORS,
CONSUMERS' METERS & GOVERNORS,

AND OTHER GAS APPARATUS. ALSO,

METERS FOR MEASURING WATER.



IMPROVED LOW-SPOUTED GAS-METER,

WITH

NEW PATENT FLOAT ARRANGEMENT.

The Float A is partitioned off from the front frame considerably below the water-line, and is pierced perpendicularly by a tube B.

A large gas-way, C, is left between the top of the partition and the valve-seat. The small tube D, in which the float-wire works, is fixed to the top of the partition, and comes down below the water-line inside the tube B. The float-wire is soldered to the float at E, so as to allow water to pass into the tube D, in order to seal it. The chamber above the float is open to the outlet through the hole K.

The action of this float is exactly opposite to that of ordinary meters. The float is elevated by sudden pressure, and the valve cannot be closed except through want of water.

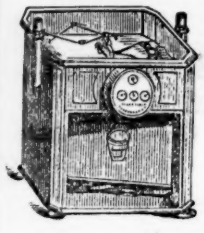
W. P. and Co. beg especially to call the attention of Gas Companies and others to this New Patent Meter, which entirely overcomes the difficulty experienced by ordinary wet meters, owing to the short range of the float, which is necessary in order to meet the requirements of the "Sale of Gas Act."

They are prepared to supply

TEST GASHOLDERS,

of the most approved description, graduated by the Standard.

BOULTON'S PATENT DRY GAS-METERS,



Of which upwards of 24,000 are at present in use, having gained for themselves an unparalleled patronage from all the principal Gas Companies and Consumers, on account of their unerring registration and the superior workmanship and materials used in their construction, enables the Patentee to sell them now at competitive prices with those of other makers.

Every description of Improved Wet or Patent Dry Meters and Gas Apparatus manufactured by

JOSEPH BOULTON,

28, BAGNIGGE WELLS ROAD, CLERKENWELL.

All Meters warranted to comply with the requirements of Lord Redesdale's "Sale of Gas Act."

JAMES OAKES and CO.,

ALFRETON IRON WORKS, DERBYSHIRE,

AND

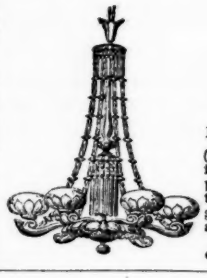
WENLOCK IRON WHARF, 20, WHARF ROAD, CITY ROAD, LONDON,

Beg to inform Gas and Water Companies and the public, that they keep in stock in London all the CASTINGS in general use in Gas and Water Works, including best cold-blast Iron Retorts, Socket and Flange Pipes of all sizes, Bends, Branches, Syphons, Lamp Columns of various patterns, &c.

N.B.—Orders for Cast-iron Tanks, Girders, Columns, Cylinders, and all irregular castings, will have immediate attention.

CHARLES HORSLEY, Agent.

C. H. is prepared to carry out the warming and ventilation of public buildings, &c.; also civil engineering in general.



F. & C. OSLER,

45, OXFORD STREET, LONDON;

Manufactory—Broad Street, Birmingham—Established 1807,

MANUFACTURERS OF GLASS CHANDELIERS, GLASS LUSTRES, TABLE GLASS, &c. &c.

ELEGANT CRYSTAL GLASS CHANDELIERS, for GAS, from £4 upwards (Made from "REGISTERED" DESIGNS), with GLASS BRANCHES, &c.; suitable for DRAWING-ROOMS and BALL-ROOMS. The more extensive use of GAS in private dwellings has induced Messrs. OSLER to direct their particular attention to the manufacture of this class of articles—which, with a view to their general adoption, are offered at very moderate prices. Purchasers can select from a great variety of patterns, to which additions are being constantly made.

THEATRES, CONCERT, ASSEMBLY, AND BALL ROOMS LIGHTED BY ESTIMATE ON THE LOWEST TERMS.

TRUSS'S PATENT ELASTIC PIPE-JOINT,

FOR GAS AND WATER-MAINS, AND STEAM PIPING,

Is the only PERFECT joint that has ever been constructed, and supplies the long-felt desideratum, by allowing for the expansion and contraction of metals, and for oscillation and deflection, without impairing the joint. Gas Companies will effect an incalculable saving in adopting it, as compared with the present imperfect mode of jointing.

Drawings, Estimates, and every particular, furnished on application to

THOMAS SEAVILLE TRUSS, C.E., 53, GRACECHURCH STREET, LONDON, E.C.

PERRENS & HARRISON,

THE LYE FIRE-CLAY AND BRICK WORKS,

STOURBRIDGE,

Successors to the late Firm of **J. & W. KING**, and Sole Proprietors of their well-known CLAY MINES, are prepared to Supply

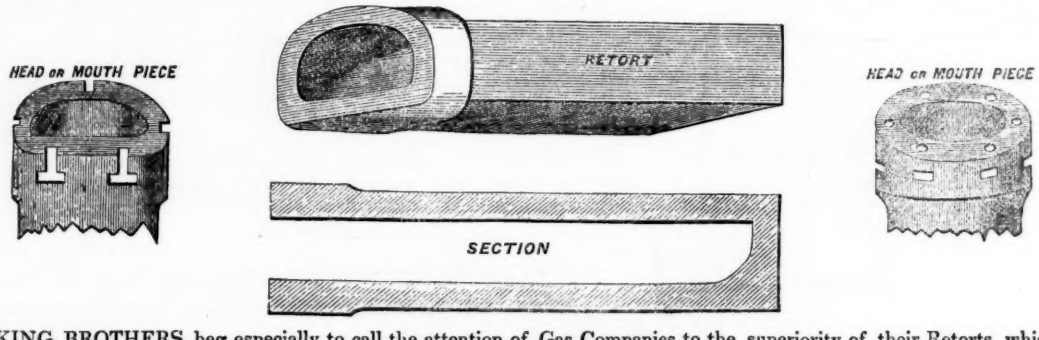
GAS-RETORTS,

CLIFT'S PATENT GAS-OVENS AND FIRE-BRICKS

of all descriptions, the superior quality of which will, they are confident, secure them further orders.

KING BROTHERS,

STOURBRIDGE FIRE-BRICK AND RETORT WORKS,



KING BROTHERS beg especially to call the attention of Gas Companies to the superiority of their Retorts, which are made from the celebrated STOURBRIDGE FIRE-CLAY. Mr. King has patented a Kiln for Burning Retorts, by which Patent all Cold Air is excluded from the Kiln while burning, thus rendering them

FREE FROM CRACKS AND CORRECT IN FORM.

By great care in Manufacturing, combined with the advantages in burning, a VERY SMOOTH SURFACE is obtained, rendering them less liable to carbonize.

RETORT OVENS, FIRE-BRICKS, GUARDS, SADDLES, RABBITTED BURS, FLUES, AND QUARRIES, ARE ALL MANUFACTURED OF THE SAME QUALITY OF CLAY.

Every Retort and Brick is branded "King Brothers, Stourbridge."

FIRE-CLAY GAS RETORTS.

ESTABLISHED IN 1795.

JOSEPH CLIFF,

WORTLEY FIRE-BRICK WORKS, near LEEDS.

THESE RETORTS are unrivalled in excellence, being the BEST FINISHED INTERNALLY, and THE MOST CORRECT IN FORM, of any in the Kingdom. From the peculiar composition used in working up the face of the material, they are rendered unusually smooth, close, and FREE FROM SURFACE CRACKS, thus, in a great measure, preventing leakage and the adhesion of carbon to their interior surface.

To meet the yearly increasing demand of UPWARDS OF THIRTY SEASONS and to carry out the late improvements in the manufacture, the Premises have been re-erected and much enlarged, and Engineers may rely WITH CONFIDENCE on their orders being completed with a greater regard to despatch than by any other House.

THE WORKS ARE WELL SITUATED

For EXPORT from the Ports of { LONDON, LIVERPOOL, HULL, MIDDLESBRO', HARTLEPOOL, and STOCKTON.

FIRE-BRICKS, LUMPS, GUARDS, TILES, AND CLAY OF THE SAME QUALITY.

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STOURBRIDGE FIRE-CLAY WORKS.

E. BAKER and CO.

(Contractors to Government).

24 WHARF, HARROW ROAD, PADDINGTON, W.

Every article manufactured at their own Works and Mines, Brierley Hill.

FIRE-BRICKS, Lumps, Squares, Tiles, and Gas Retorts of all dimensions.

CRUCIBLE and CEMENT CLAYS.

GARDEN EDGINGS, of various patterns.

BUFF and ORNAMENTAL TILES.

CLINKERS and STABLE PAVINGS, noted for hardness and durability, being perfectly non-absorbent.

Shipments on the shortest notice.

WROUGHT-IRON Guides for Gas-HOLDERS, when Trussed upon scientific principles, are more capable of resisting strains, in every direction, than Cast Columns of any form can be; and weigh only one-fifth as much as the latter. Designs and Working Drawings for Guides and Ties can be obtained of the Inventor, CHARLES DIXON, C.E., Chichester, SUSSEX.

NOW READY,

VOL. VIII. of the JOURNAL of GAS LIGHTING, WATER SUPPLY, and SANITARY IMPROVEMENT, for 1859, price 21s., bound in cloth and lettered. A few copies of Vols. II., III., IV., V., VI., and VII. are still on sale.

W. B. KING, 11, Bolt Court, Fleet Street.

GAS COAL.

BEAL, WALKER, and CO., Coal and COKE MERCHANTS, No. 1, Walker's Buildings, SHEFFIELD, beg to inform the Directors and Managers of Gas Companies, that they are in a position to contract for the supply of the different sorts of best Gas Coal, such as best Silkstone, Barnsley, and others, at the lowest prices, which may be had on application at the above Office.

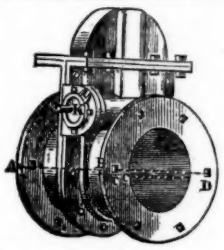
ALFRED PENNY, Engineer

WENLOCK IRON WORKS,

WHARF ROAD, CITY ROAD, LONDON.

Mr. PENNY begs to inform Gas and Water Companies that he undertakes the erection of new, or the alteration of existing, works; and that he may be consulted generally on all matters connected with gas and water supply. He is also prepared to supply best Cold-blast Retorts, Socket-Pipes, and Connections, Iron Borings, &c. &c., and all the necessary Castings used in Gas and Water-Works.

*** Country orders executed with care and despatch.



BRYAN DONKIN & CO.

keep always on stock their

IMPROVED GAS VALVES

from 2 inches to 18 inches, price 11s. 6d. to 13s. 6d. per inch diameter

List of prices, with full dimensions of all sizes up to 27 inches, to be had on application.

These Valves are all proved to 30 lbs. on the square inch before leaving the works.

BRYAN DONKIN & CO.,

ENGINEERS,

NEAR GRANGE ROAD, BERMONDSEY.

BIRTLEY IRON WORKS,

CHESTER-LE-STREET, DURHAM.

Manufactory for every description of Casting and Machinery for Gas Works and Water Works.

Warehouse in London for Cast-iron Pipes and Connections of all sizes and in any quantity, Scott's Wharf, Bankside, Southwark.

Office in London, Mr. E. M. PERKINS, 78, Lombard Street.

JOHN ROGERSON and CO.,

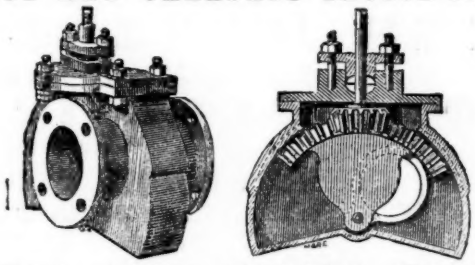
NEWCASTLE-ON-TYNE & MIDDLESBRO'-ON-TEES.

Wrought and Cast Iron Pipes, Cast-Iron Retorts, and all kinds of Foundry Work necessary for Gas-Works. Fire-Bricks and Clay Retorts. Gas Coals of every description. Pig, Bar, and Plate Iron.

LONDON HOUSE:

12, ROYAL EXCHANGE BUILDINGS.

BEST AND CHEAPEST SLUICE-COCK.



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Above 3-inch diameter, price 10s. per inch. Brass face, 6d. per inch extra.

Can be taken to pieces without being removed from the line of Piping.

NORTH WILTS FOUNDRY, DEVIZES.

Wholesale Agents, Messrs. S. and E. RANSOME, 31, Essex Street, Strand, E.C.,

Where a Sample may be seen.

WILLIAM INGHAM AND SONS,

WORTLEY FIRE-BRICK AND RETORT WORKS,

Near

Leeds.

W. INGHAM and SONS, having for many years been extensively engaged in the Manufacture of

RETORTS AND FIRE-BRICKS FROM THE CELEBRATED WORTLEY FIRE-CLAY,

beg to call especial attention to their RETORTS, which have for many seasons proved to be unsurpassed in quality by any in the Kingdom, their FREEDOM FROM CRACKS and the ADHESION OF CARBON rendering them worthy the attention of all parties interested in the making of Gas.

The Works are of such magnitude as to ensure the prompt execution of orders to any extent.

Estimates for Setting, or Bricklayers sent when required.

GAS OVENS IN SEGMENTS OF EQUAL QUALITY.

London Agents: CHADWICK and AKEROYD, Willington Stone Wharf, Regent's Park Basin.

A large stock of Fire-Bricks, Fire-Clay, Terra Cotta, and Drain-Pipes of all sizes kept in London at CHRISTIE & CO.'s Wharf, 64, Bankside, Southwark, where all particulars of Prices, &c., may be obtained.

N.B.—*Export orders continue to have prompt attention.*

SALE OF GAS ACT.

MESSRS. CROLL, RAIT, AND CO.,

Manufacturers of Croll's Patent Improved

DRY GAS-METER,

Also Manufacture and Supply

TEST GAS-HOLDERS,

And other Apparatus required by the Inspectors appointed in pursuance of the above Act.

Application for particulars to be made to the Factory,

CANAL BRIDGE, KINGSLAND ROAD, LONDON, N.E.

ALEXANDER WRIGHT,

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MANUFACTURER OF

CONSUMERS' COMPENSATING & NON-COMPENSATING WET GAS-METERS,

Of the best material and workmanship, carefully adjusted to meet the requirements of the SALES OF GAS ACT.

STATION-METERS & GOVERNORS,

WRIGHT'S REGISTERING PRESSURE-GAUGE, EXHAUSTER REGISTER, & REGULATOR;

STANDARD TEST GASHOLDERS;

Consumers' Governors; Inspectors' Pocket, King's, and all other kinds of Pressure-Gauges; Thermometers for Condensers, Pressure Registers, &c., &c.

EXPERIMENTAL TESTING APPARATUS,

Employed by the best experimenters in this country and on the continent, and by the Gas Testers in the London districts.

PHOTOMETERS, SPECIFIC GRAVITY APPARATUS, BI-SULPHURET OF CARBON TEST, THOMPSON'S BROMINE AND HEATING POWER OF FUEL TESTS, IMPROVED ALKALIMETER, EXPERIMENTAL METERS AND GOVERNORS, MINUTE CLOCKS, &c., &c.

"Analysis of Gas for Practical Men," by A. WRIGHT, M. Inst. C.E., post-free for 13 Stamps. PRICE-LISTS ON APPLICATION.

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LONDON, S.

THE ORIGINAL INVENTORS, AND FIRST MANUFACTURERS OF THE

Patent Wrought-Iron Tubes for Gas, Steam, Water, &c., &c.; Enamelled Tubing, and Glazed ditto.

Russell and Howell's Homogeneous Tubes; and Agents for G. F. Muntz's Solid Brass Tubes.

EVERY VARIETY OF FITTINGS.

TRADE MARK.

D. HULETT and CO., 55 and 56, HIGH HOLBORN, LONDON,

PATENTEES and MANUFACTURERS of the ONLY GOOD MERCURIAL GAS REGULATOR,

invite the attention of Gas Companies and the Trade generally to their Improved GAS-METERS, which they warrant equal to any in Quality, Workmanship, and Simplicity of Construction, and the only Meters from which Gas cannot be obtained without being duly registered.

MANUFACTURERS OF

GAS CHANDELIERS, GLASS LUSTRES, HALL LANTERNS, VESTIBULES, BRACKETS, PENDANTS;

DOUBLE CONE, ALBERT, SHADOWLESS, & EVERY DESCRIPTION OF BURNER, UNION JETS, BATSWINGS, ETC.;

IMPROVED FULL-WAY CARTER'S VALVES (much approved of);

GAS-STOVES, and every article connected with Gas Apparatus.

CAST & WROUGHT-IRON PIPE, BLACK & GALVANIZED. COPPER. TIN, BRASS, & COMPOSITION TUBING.

D. HULETT'S IMPROVED SERVICE CLEANSER

for clearing out Mains, Services, and Interior Fittings—60s. net.

Boyle's Patent Silvered Glass Combination Reflectors and Outside Lanterns.

Sole Manufacturers of Church and Mann's Photometer.

Large Pattern Books, with every description of Gas-Fittings, Chandeliers, &c., with complete Book of Prices, 12s.

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